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MACHINERY:

VOL I. No 7. PUBLICATION OFFICE: 411-413 PEARL STREET, NEW YORK CITY. MARCH: 1895.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

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LONG AND SHORT CONNECTIONS. W. H. WAKEMAN.

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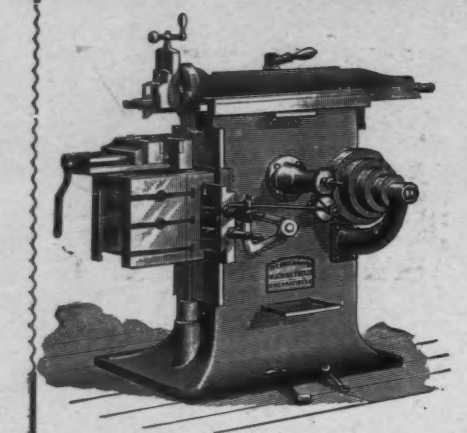

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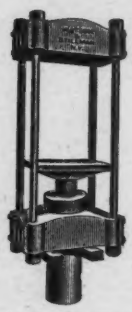

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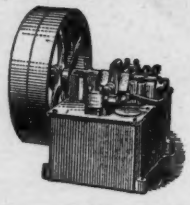

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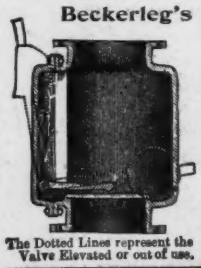

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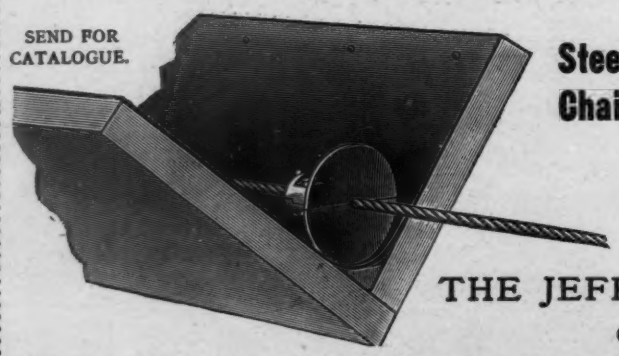

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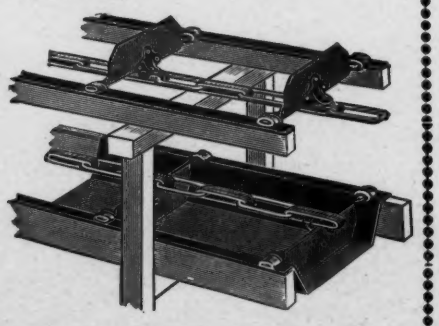

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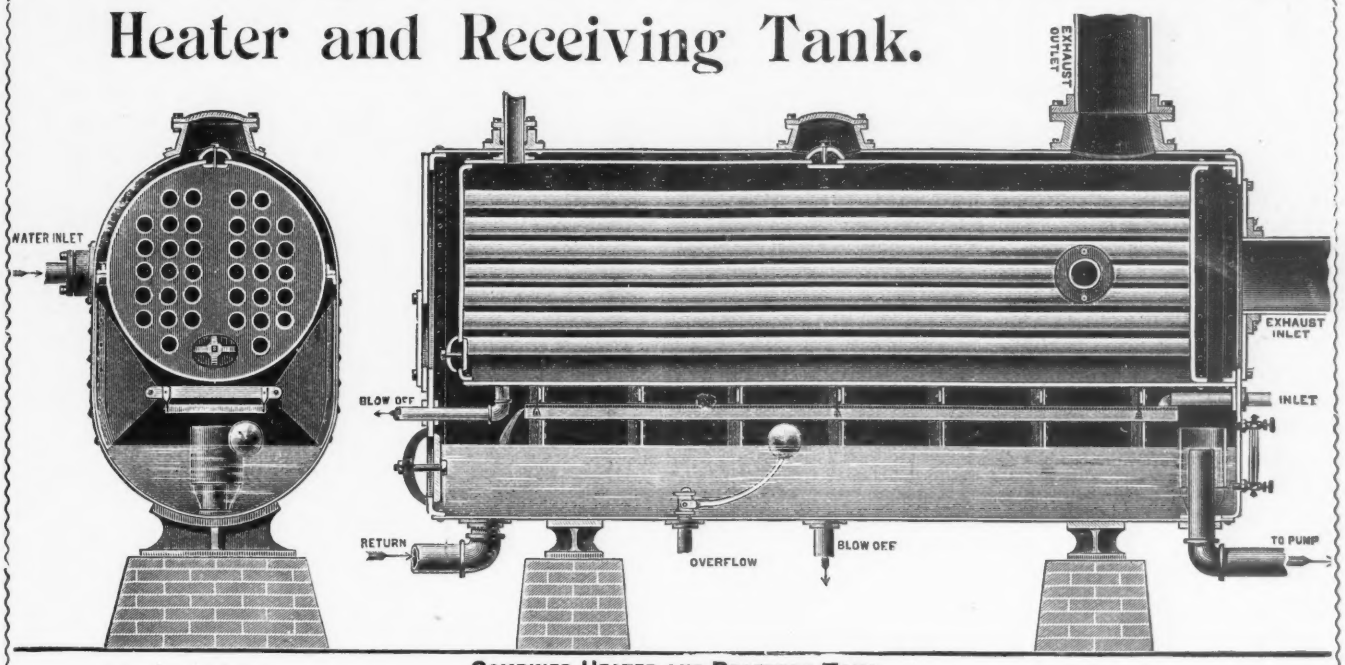

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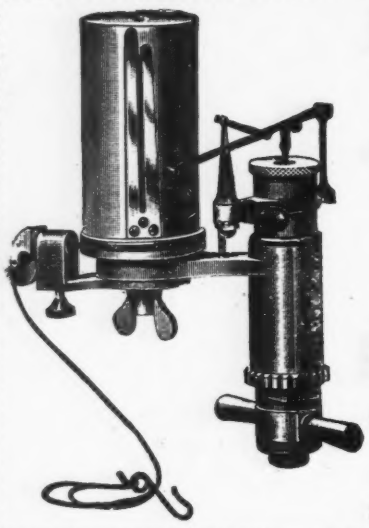

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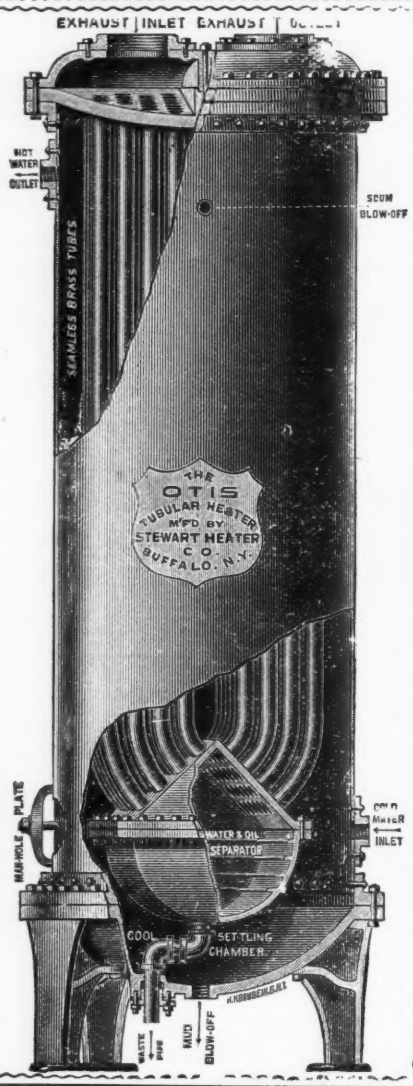

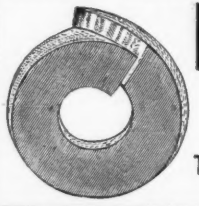

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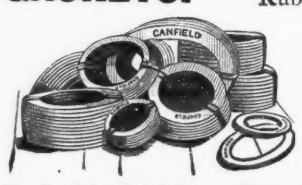

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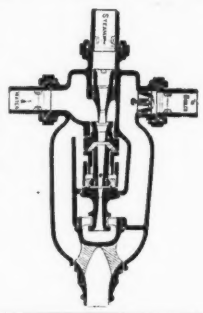

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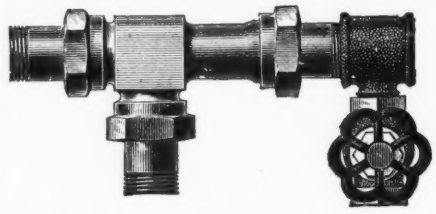

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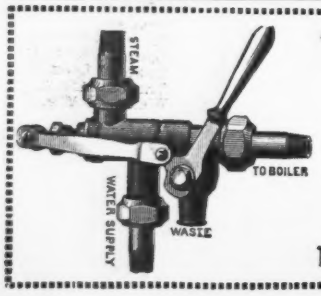

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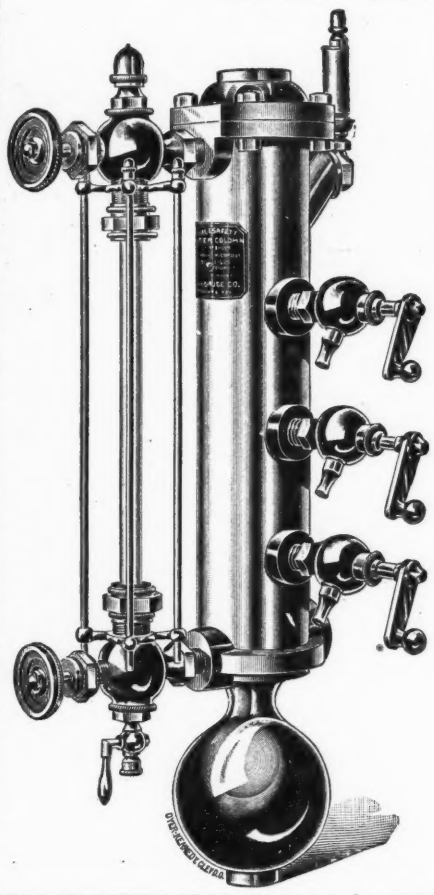

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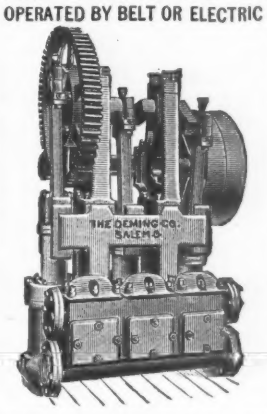

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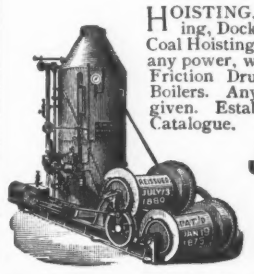

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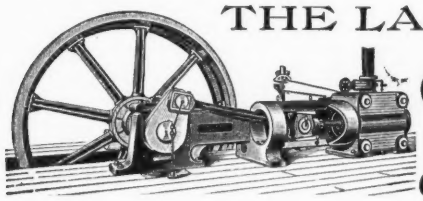

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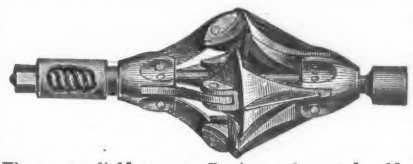

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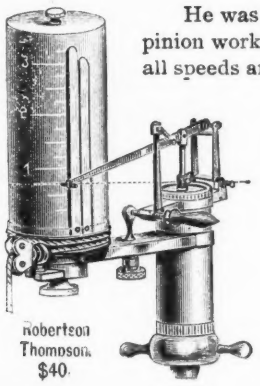
SHAKESPEARE SAID,

"Ah, there's the rub."



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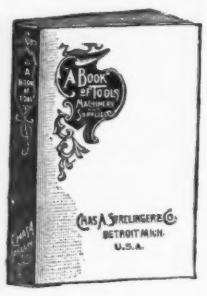

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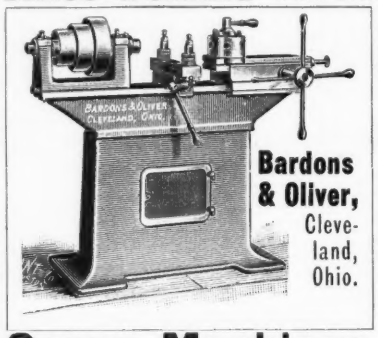

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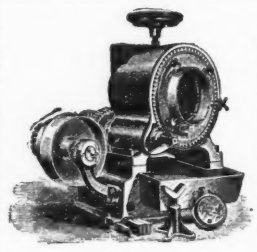

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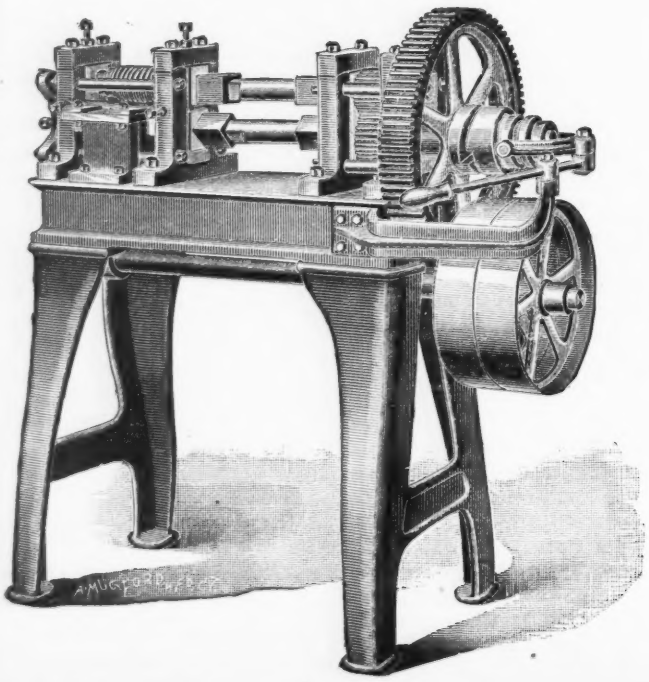

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VOL. 1. March, 1895. No. 7.

PROPER METHODS OF STEAM PIPING.

FREDERICK FOSDICK.

STEAM PIPING is one of the important parts of a steam plant, and its proper arrangement and construction are of great consequence to the builders and users of steam engines. All I can touch upon in this article is that part of the piping from the boiler or boilers to the engine or engines, and all that I may say will apply to this.

Poorly arranged piping may destroy the economy of the most economical engine; may occasion most serious wear in an engine of the best workmanship, and may badly wreck the very strongest engine. As these results are commonly, though wrongly, believed by its user to be the fault of the engine, it is exceedingly important for the reputation of the builder that there be no cause for them, for such a mistaken belief injures him almost as much as if it was a true one; and as the loss of fuel, expense for repairs, and perhaps loss of time, are borne by the user, it is still more more important for him that there be no such cause for them.

As an engine builder of twenty-five years experience I can say that ill-designed steam piping has caused us more trouble and expense than all other difficulties put together, and yet the average steam fitter fully believes that he knows all there is to be known in this matter and needs no instruction or criticism from any one. And first, economy demands that the pipe and valves shall be of sufficient size to carry practically the pressure at the boiler to the engine. With steam at 75 to 100 pounds, the velocity of flow per second should not exceed 80 feet if pipe is reasonably short and straight, or 65 to 70 feet if pipe is long or with many bends, and the size needed for this should commence at the opening from the boiler and continue to the engine, straightway valves being preferable. Elbows with a long sweep are advisable and tees are to be avoided if possible, an ⅛ bend and a Y paying a large dividend upon their cost. (See Fig. 1.) A tee will inevitably cause some loss of pressure because of the power absorbed in accomplishing the abrupt change of direction of the flow of steam, this being to a less extent true of a short elbow, but the long sweep elbow and the ⅛ bend with Y give a long curve and gradual change of direction of flow without noticeable change of pressure.

Through ignorance, or desire to save first expense, or because certain pipe is already in place, either a smaller size of pipe is used than the engine calls for, or the size at engine is used where the engine is a long distance from the boiler, or where there are many bends, or both, and there results a loss of pressure and a consequent loss of economy in use of steam which would pay the difference in the cost of piping once, or possibly several times, in the course of a single year.

Pipe, then, of proper size and easy bends is essential to economy, and if two or more boilers are to be used for one engine the pipe from each to the common receiver should be ample for its capacity and as direct as possible, or if more than one engine is to be supplied the pipe should be of ample capacity for all drawing at once, and the connection to each should be such as to avoid abrupt turns if possible. I have taken indicator cards, just above the engine, from insufficient steam pipes, where the pressure would be reduced nearly 10 pounds when the engine began to take steam, rising again after point of cut-off, when no more steam was drawn for cylinder. This is a cause of serious and ceaseless waste.

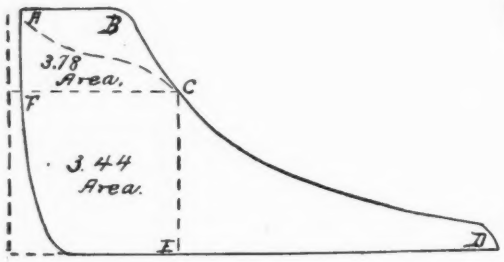
For economy also, the steam pipe should be carefully protected by some good non-conducting covering, either in plaster or sectional form, taking care in the latter that no air leaks are allowed, which permit a circulation of air inside the covering around the pipe. I have been repeatedly told by steam users that in a boiler house, or other warm room, no covering is needed, but seldom is the temperature in such rooms over 100 deg., usually it is much less, while steam at 80 to 100 pounds pressure has from 325 to 342 deg. of heat, and the radiation is proportionately as much in such rooms as in cooler, with equivalent condensation and loss of fuel.

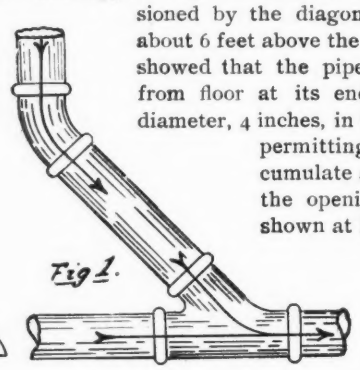
In every automatic cut-off engine there is large internal condensation occasioned by the difference between initial and final temperatures, but condensation in the steam pipe when uncovered, or poorly covered, increases tremendously the cylinder condensation because of the moisture already entrained in the steam, like the cloud loaded with moisture, ready by a little drop in temperature to break and fall as rain.

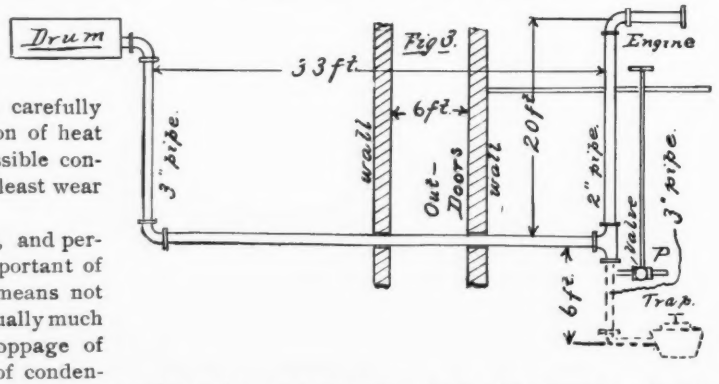
When we consider that at 80 pounds of steam every cubic inch of condensed water represents 310 cubic inches of steam, and that the 883 deg. of heat which were needed to turn that water into steam are lost, the value of a good pipe protection

in the way of economy will be realized. This undue condensation has also the effect of reducing the initial pressure in the cylinder, and the accompanying card shows conclusively the very serious loss which may thus arise from this or from insufficient pipe, or both. In its full outline A B C D E it is a perfect theoretic isothermal card at 80 pounds pressure, ¼ cut-off, 3 per cent. clearance and 40 spring. It had an area of 3.78 square inches, giving an average pressure of 39 pounds. If taken from an engine with cylinder 12 by 14 inches making 125 revolutions, it would show $66\frac{8}{10}$ horse power. The dotted line from A to C represents fairly the steam line which would be obtained were the pipe insufficient or subject to large condensation. The area of A C D E is but 3.44 square inches, or with same engine as before it would represent $60\frac{8}{10}$ horse power only, a loss of 9 per cent. with same consumption of steam, the loss being occasioned by the power needed to force the steam through the insufficient pipe. That equal amounts of steam are used is shown by the fact that when the piston has travelled from F to C each card shows at these equal volumes the same pressure, E C = 55 pounds. This would be subject to slight correction because of difference in temperature, but practically 9 per cent. would be the loss, and this is not an exaggerated case. With a 100 h. p. engine this would mean, say, 40 tons of coal in 300 days, or perhaps $150.00 per year, most of which could be avoided by proper construction of piping and small expense at first.

Second, as to wear. Water in steam will cut the edges of valves and ports as it passes them, sooner or later causing leakage and improper distribution of steam with improper strain upon the working parts. Water will also sometimes neutralize the action of oil in the cylinder and permit cutting of surfaces the same as if no oil was used, hence the importance of pipes sufficient in size and so carefully protected against radiation of heat as to permit the least possible condensation and hence the least wear from this cause.







Third, as to wreckage, and perhaps this is the most important of all, as a broken engine means not only cost of repairs, but usually much greater loss through stoppage of production. The water of condensation entrained with the steam, and carried with it into and out of the cylinder, very seldom is sufficient to cause breakage, though it may occasion disagreeable slapping in the cylinder and loosening of connecting-rod boxes, but where "pockets" are allowed in the pipe where water may collect, the water gradually increasing until an unusual demand by the engine for steam shall carry it along bodily in front of the steam into the cylinder, then injury to the engine is only a question of time, more or less disastrous according to amount of water and circumstances under which the engine is being run. Engines are not made to run with water, and though valves may be made to lift from their seats, or relief valves may be put in, any considerable amount of water so carried into a modern first-class engine with close clearances, will inevitably result in broken crank, or broken cylinder, or bent connecting-rod, or all these and sometimes more. Improper arrangement of exhaust pipes will sometimes do the same thing, but that is beyond the scope of this writing.

If a steam pipe can slope back all the way from the engine to the boiler with enough pitch to permit the water of condensation to run back on the lower side of the pipe, against the resistance of the outflowing steam, into the boiler, it is best, otherwise there should be such a slope as far as may be readily possible and then a constant drop all the way to the engine without any rises after beginning to drop, unless the pockets so made are carefully trapped so that they are automatically and surely kept drained. Steam fitters and "practical" men, so called, have insisted that such a pocket once drained when engine is started, would be kept drained by the velocity of the passing steam so long as the engine should be kept running. A long experience with various engines and more various steam piping have conclusively proved to me the contrary. About eighteen years ago an engine which had been running satisfactorily for three years broke its crank-pin. The man who replaced it looked over the piping carefully and said it was all right. In two days the new pin broke, and a more critical examination of the piping and boilers showed no reason for water. When a third pin broke, in a few days, I went to the place to see if I could discover the cause. The pipe rose from the boiler, passed into the engine room horizontally for about 10 feet, then diagonally across the room about 60 feet, with an apparent rise of at least 3 feet in that length, and then dropped vertically, say, 6 feet to the engine, a first-class pipe to all appearance. The apparent rise of 3 feet was so marked that no special attention had been given that 60 feet until I happened to notice that the two ends on opposite sides of the room were exactly level with the wall-plate upon which the roof rafters rested. The apparent 3 feet rise was an optical illusion occasioned by the diagonal passage of the pipe about 6 feet above the line of vision. A level showed that the pipe was the same height from floor at its ends and sagged its own diameter, 4 inches, in the center of the 60 feet, permitting water to gradually accumulate as shown in Fig. 2, until the opening at lowest point, as shown at B, was too small to allow enough steam to pass for the need of the engine, when, like the action of the wind upon the surface of a pond, it raised a ripple, making the space for passage of steam still less, then a large ripple and then a closing of the opening B altogether, carrying all the water before it into the engine cylinder and breaking the pin. The pipe at this point was raised 5 inches and supported, and the engine has been run ever since with no broken pins.

Another case some years ago occurred where several forged steel crank shafts were successively broken in the engine, the owner claiming they had flaws in them. An examination of the piping showed, as by Fig. 3, a 3 inch pipe dropping from end of a large steam drum 10 feet, thence passing horizontally 33 feet (6 feet of which was out of doors) to a tee which had a valve P in it which could be opened from the floor 15 feet above, and from the tee a 2 inch pipe was taken up 20 feet to the engine cylinder. When the engine was started the valve P was opened until water was drained from pipe and then closed. The long uncovered pipe made an excellent condenser, and the water, as in the other case, accumulated until there was not enough room over it for passage of the required steam when it was, as before, carried in front of the steam into the engine and broke the shaft. At the tee where was the valve P, a piece of 3 inch pipe 6 feet long was placed, and at the bottom of this a good trap, keeping the pipe empty, and no more shafts were broken or trouble had with the engine.

I could multiply such instances were it necessary, but I have already written enough, and if by it I can induce steam fitters and engine users to be more careful in designing and constructing steam pipes to engines, I shall have accomplished something to the decided advantage of users and indirectly to myself as an engine builder.

* * *

A USEFUL lubricant for turning steel can be made of two parts of petroleum and one part of turpentine.--*The Engineer* (London.)

AN ENGINEERING EXPERIENCE.

S. ASHTON HAND.

Josh Billings once said: "Experience is a school in which the tuition is free, but the incidental expenses are simply enormous." I think most engineers will agree with him.

Some years ago the writer was called upon to take charge of an old established iron works, which was suffering from what Mrs. Partington would call the "Serio-final come and get us." The works employed between 700 and 800 hands, and had all the work they could swing, but were losing money. The owners wanted things rehabilited and modern methods established, and expressed their willingness to put up the necessary funds.

The machine shop of the establishment was naturally the first place to be looked after. It was a two story shop about 80 by 150 feet. The shafting "ran out" like a dog's hind leg, and was driven by the noisiest kind of mitre gears, power being transmitted from the smith shop shafting in an adjoining L. The tools were old and were so placed as to give one the impression that they had been blown in by a cyclone, and had been belted up just where they landed.

The most modern tool in the shop was a Bancroft & Sellers lathe, built in 1854. None of the other tools had names on them, being so poor that their makers were probably ashamed to make their names known.

Most of the lathes were of the chain-feed type, and the planers had the old tumbling cannon-ball arrangement to help shift the belts, and the operator was lucky if he wasn't laid up at least once a month from having the cannon ball flop over on his foot when the platen was reversed. The average cutting speed of the planers was about eight feet per minute, without any increase on the return stroke.

The largest planer was about 5×5×20 feet, and stood in the darkest part of the shop, almost against the door where the most of the work was brought in and taken out. When large pieces had to be taken in or out, it often was a problem whether the planer would have to be moved or a hole knocked in the wall.

At some previous time this planer had been called upon to plane a piece of work about 4 inches wider than would pass through the housings, and some smart "Alick" had chipped enough off the face of the housings where the cross-rail was bolted, to let the work pass through. The consequence was that a pair of special clamps had to be devised to clamp the cross-rail to the housings. These were cumbrous affairs and necessitated the services of two or three laborers besides the planer hand, every time the cross-rail was to be raised or lowered.

The men were all old-timers, who had never heard the word "hustle" in all their lives. I think, Mr. Editor, you must have seen such men in your travels—the kind that wear old-fashioned plug hats while at work, and who delight in sitting on a nail-keg, watching their machines take "atmospheric cuts." The most of them still vote for Andrew Jackson and none of them know the war is over.

I wanted to have a lot of first-class funerals and get some good young fellows with modern ideas; but ye Gods, what kind of a figure would a modern machinist cut among broken-backed planers and asthmatic chain-feed lathes that were built before the flood?

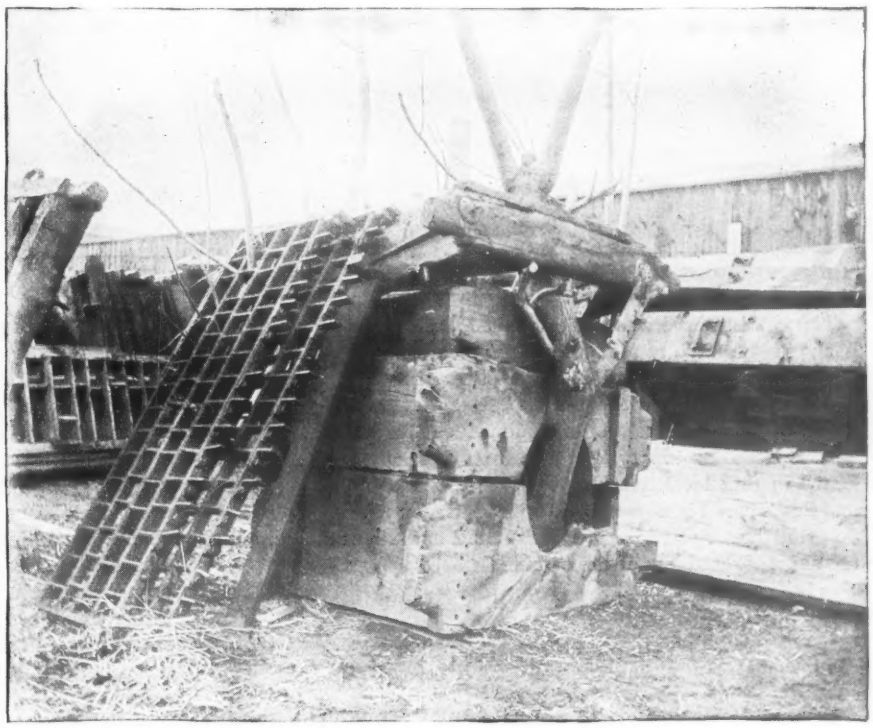
As the appearance of such a place can be much better illustrated than described, I send you a sketch of the second floor of the machine shop during working hours. My greatest regret is that I did not take a series of photographic views of the whole establishment.

There were five steam engines located in different parts of the works, all of which should have been in the cupola long ago. One, a 100 h. p. vertical Corliss engine, had been through a fire, and the iron steps leading from the floor to the starting platform and the platform itself had been destroyed. In lieu thereof a temporary wooden staging and set of stairs had been put up, but were never replaced with anything better, and so became permanent fixtures. This engine drove direct a line of 6 inch shafting placed under ground. The shafting was 14 inches out of level in its length of 110 feet.

Another engine, a 40 h. p. horizontal Corliss, had been bought second hand. The steel latches engaging the wrist-plate mechanism with the valve gear were so worn that they would not take hold. The whole business was tied together with belt lacings, letting the engine take steam nearly the full stroke. The governor was thus relieved from duty, and the speed had to be controlled by the stop valve. This is a fair sample of the general condition of things.

The shop floors were thick with dirt and grease, rendered as hard as the traditional "Hinges of the gates of Hades," by long standing and much tramping over; windows opaque with accumulation of dirt and filth, walls and ceilings black as the ace of spades, and junk everywhere from the pattern shop to the office.

Adjacent to the works was an enclosed lot about four acres in area, and used for the storage of foundry flasks, pig and scrap iron and all sorts of miscellaneous truck that no other place could be found for. In hunting over this lot for a special flask that had not been used for some time, I found two flasks that had been in that particular spot long enough for a maple tree 10 inches diameter and 22 feet high to grow up through them. This is not a joke. I had some truck cleared away and took a photograph of the combination. I send a copy, and it can readily be seen where the tree has been flattened against the cope of the lower



HOW LONG?—AN ENGINEERING EXPERIENCE.

flask during its growth, and also how it has raised the cope up from the drag of the upper flask. You can get some idea of sizes when I tell you that the lower flask was used for moulding 36 inch globe valves.

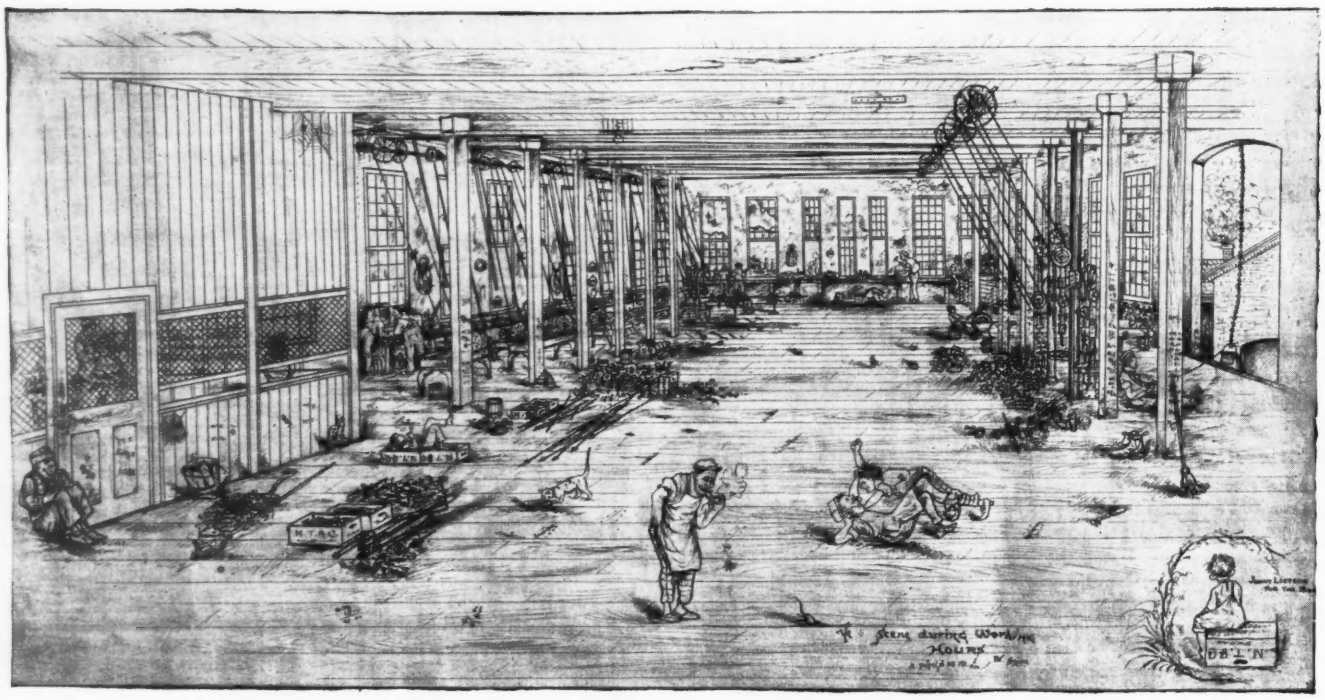
Now, Mr. Editor, I don't want either you or your readers to think because my hairs are gray that I am a Methusaleh and am

writing about some shop that existed during pre-historic times. No such thing. My gray hairs were caused by early piety and sitting in damp churches, and I am willing to register my Heaven bound oath that the shop of which I am writing was under my charge not more that eight years ago.

I began operations by cleaning up the shops and the windows, whitewashing the walls and ceilings, repairing such tools as were worth it, and changing their positions to better facilitate the handling of the work. Then I ordered such tools as were absolutely necessary, at which time the fun commenced.

The owners thought I had accomplished a great deal with very little expenditure of money, and wanted me to do more of it. They pleaded hard times and a depleted exchequer, and thought more work could be gotten out by driving the men and using the tools we had. I would not be bluffed by any such talk as that, and reminded them that they had got me there to modernize the works, and had promised to put up the necessary funds. After a long argument entirely devoid of moral remarks and Scriptural quotations on either side, they yielded the point and the tools were bought, but their pocket nerves were touched and it made their back teeth ache. They finally got over it and things ran along smoothly.

After thoroughly looking into matters and carefully weighing everything, I prepared and submitted a detailed report showing just what would be necessary to put the concern on an equal footing with its competitors.



IN THIS MODERN MACHINE SHOP—AN ENGINEERING EXPERIENCE.

The pocket nerve was again touched, and the tooth-ache came back to stay. We agreed to disagree. I left them to try and earn my butterless bread in some other shop, and they tried to economize by doing without a superintendent, letting each foreman run his department on an independent basis.

It is needless to say that the hum of industry is no longer heard in that locality. The lot where the combination of tree and flasks stood is now a public park, under the shadow of the deserted factory buildings, which stand as a silent monument to the short-sightedness of the owners.

* * *

MORE ABOUT PATENTS.

R. D. O. SMITH.

It is quite refreshing to read something fair-minded about patents, and I wish to express my acknowledgments to Mr. Whittlesey for his brief article in MACHINERY for December. There is but one point about which I wish to say a word, and that has more to do with the air than the substance of the thing.

A large portion of the misinformation and misconception concerning patents grows out of a misconception of terms. Patents are by many classed among *monopolies*—a word clothed with odium since the days of Elizabeth. Others class them with special privileges which are almost as odious in the nostrils of the people. Others call them *grants*, a word which implies that something is parted with, and inferentially parted with insufficient compensation. All of these terms include an idea of something objectionable, oppressive or unjust. Mr. Whittlesey says a patent is a privilege, not a right. His definition is more mild, but scarcely more correct. It is neither one of these. It is a contract of sale, authorized by law, it is true, but not in any way dependent upon the law as far as the inventor is concerned.

If the Government desires to built a new Post office in some city the department must first obtain from Congress authority to purchase the necessary ground, but the owner of the ground does not need any authority from Congress to enable him to sell.

Just so the inventor is in possession of a new and useful invention—not by grace of the law, but by the Divine act of creation. Having created it, it his to keep, to use, to sell or to give away at his pleasure, and this right is undisputed. Many inventors for their own reason lock up their inventions—they have the right to do so. Many again use them in secret, and the public not only get no knowlege of them, but never claim any right to knowledge. Again, many inventors give away their inventions, and such as will use them freely. Lastly, many offer them for sale.

All these modes of disposition are in common use.

How does he sell the invention? Congress has authorized the proper department of government to purchase it on the same terms that many men purchase real estate for a limited time, *i. e.*, upon conditions that the improvement shall revert to the original owner. The agents of the people offer that the people shall keep their hands off and permit the inventor full and free public and exclusive use of the invention during seventeen years, provided the inventor will surrender all his rights at the end of that time.

The greater number of inventions could not be used in public without going into the knowledge and possession of others, and under the terms of this offer the inventor generally considers his chance of reaping a satisfactory reward during seventeen years exclusive use in greater than during an unknown greater number of years of secret use, and about 40,000 yearly offer to accept the terms; but a considerable number prefer to take their chances in secret use, and a very large number give their inventions to the public, and another great number simply keep them to themselves—waiting some more propitious time.

Viewed in this, the only proper light, a patent is simply a sale upon conditions satisfactory to both parties, and is not properly open to aspersions of any character.

The public has no right or interest under a patent until it has expired. If it is good, self interest generally prompts the inventor to give the people an opportunity to use it; but they have no claim upon it, any more than has the man who owns the ground upon the man who builds a house upon it under the right to use for a limited time. He may long for that house ever so much,

but he has no right even of complaint. The public may desire the use of a patented invention, but they have no rights.

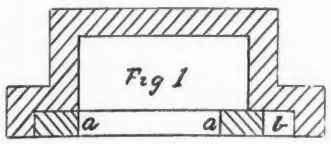
Every year we have a crop of efforts to deprive inventors of their rights, but in the nature of the case they must fail. If the patent law should be repealed, inventions which cannot be worked in secret would cease to be produced, and he is a short-sighted man who cannot see that, or who can suppose it would redound to the public good.

* * *

RECOLLECTIONS OF THE USE OF THE STEAM INDICATOR.—2.

F. F. Hemenway.

About this time Richardson invented his balanced slide valve—now well known—and a "slip valve," as he called it. The slip valve was a thin rectangular frame let into the face of the main slide. This frame was fitted very accurately, except that it had a definite longitudinal freedom, 5/8 inch or perhaps more. This space was alternately at each end, as between the forward and backward motion of the main slide, the slip remaining stationary till the main slide had traveled this 5/8 inch distance, the two then traveling together. The rough sketch, Fig. 1, which is sketched to no scale or proportions, will nevertheless give an idea of the slip just as well as something more elaborate; *a a* represents the slip valve. The main valve is supposed to be traveling from left to right, and the amount of slip is shown at *b*. On the return stroke of the valve this space *b* will be at the other end of the slip valve.



The object of all this was to control the exhaust, to delay exhaust opening and closure, but by leaving the exhaust open during the slip period, to provide free exhaustion.

Richardson reasoned that at early cut-off in the locomotive there was a very sensible loss; that the exhaust pressure dropped almost instantly, as indicated by the full line in Fig. 2. (The reader will observe that, as in the instance of Fig. 1, this and the following diagrams are simply free hand sketches, sketched to no scale.) Then he reasoned that with his slip valve expansion would continue something as indicated by the dotted lines, and that by this means the area as at *a* would be clear gain.

A locomotive 16 by 24 inches, which was being refitted, was taken and valves with the slip arrangement was made to be substituted at will for the regular valves. First the engine was tried with the regular valves, on a branch where there was a good long level stretch and almost unlimited right of way. Then the new valves were substituted. The new valves were balanced, the old ones unbalanced, and making a slight allowance for that there was no gain from the use of the new valve. The indicator told the story; told it exactly. There was no improvement in steam distribution. It was useless to go further.

It is perhaps worth noting that with this engine on level track (just the engine and tender) we were never able to exceed a speed of sixty miles per hour. Passenger engines of that day were built for a light train and a limit as to speed of forty to fifty-five miles.

It should be said that the Richardson slip valve had, previous to this experiment, been applied to several tug-boat engines and to one reversing rolling-mill engine, and had given satisfaction. It is doubtful, however, if there is one of them in use to-day. In these instances—the tug-boat and rolling-mill engines—a balanced valve was substituted for one unbalanced; it was a case of trying two experiments at the same time, in which case not much is generally known of either.

With the valves we tested against the slip valves in the experiment referred to, we did not find any such drop in pressure as Richardson had anticipated. Instead of the instant escape of steam, as predicted, it continued to push the piston along till nearly the end of the stroke, as indicated by Fig. 3, which is perhaps a little exaggerated.

In the instance of high speed, and the ports and valve motion of the locomotive engine, the steam does not escape instantly.

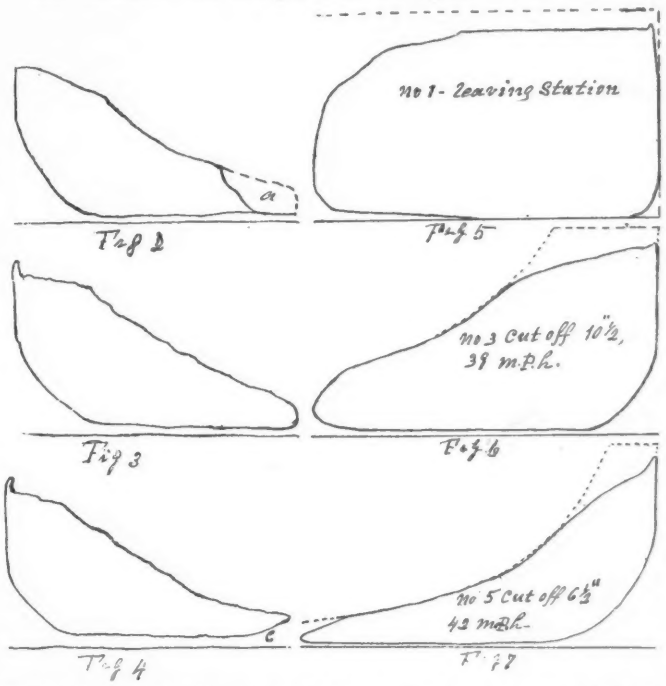
Fig. 4 would, perhaps, better represent the diagram from the slip valve. The late exhaust opening resulted in increased back pressure, as shown at C, and this counteracted any gain otherwise. With the balanced valve the case was different.

About the time Richardson invented his balanced valve, Mr. Thomas Adams, of Manchester, England, made some experiments with a view to determining the percentage of the total power of the locomotive that was expended in operating the valves and valve mechanism. He came to the startling conclusion that it amounted to 35 per cent. This he communicated to a leading English engineering journal, and it was so published. From a personal acquaintance of Mr. Adams I have no doubt he believed all he wrote.

Richardson had put some of his balanced valves on locomotives and was dazed by the conclusions of Adams. So the Richards indicator was put to work again. We did not go through the elaborate experiments that Adams went through, but we went far enough to believe that he made a mistake somewhere. We did, however, satisfy ourselves that there was a saving by taking some tons weight off the back of the valve, and some water measurements we made bore out this conclusion. It was, however, after about six months' service that the balanced valve began to show its superiority. All tests and observations had been made in comparison with another engine, the two being exactly alike except as to balanced and unbalanced valves. At the end of six months the engine with the balanced valves showed just the same diagram as when first out of the shop, while the diagram from the other gave every evidence of leak, and valves out of place from wear of connections, and was taken into the shop for repairs. The indicator had again told the truth.

Then Richardson was struck with a great scheme. That is not a fair way to put it. Perfect candor compels me to admit that I was quite as deep in the mud as he was in the mire. We had both read a good deal about steam jacketing, and we had naturally read a good deal that was not so, because there was a good deal published about it at that time that dealt more with imagination than with facts. If a steam jacket was good because it kept the cylinder hot, what was the matter with a hot air jacket that would keep it hotter, taking the waste hot gases direct from the front end? Richardson put on the jackets, and it is unnecessary to say that the job was well done. There was an arrangement for shutting off the jackets at will, and everything was complete. Armed with pyrometers and high grade thermometers a trial was made, when to our disgust we found that the hot gases would not circulate around the cylinders. Then a resort was had to exhaust steam jets (induction jets), and the trouble, so far as this went, was over. There was 500 to 600 degrees of heat around the cylinders.

The indicator was brought into use again. The tests were



made alternately with the "jackets on" and "jackets off," and at the ordinary passenger speed of that day there was no evidence of any saving, not even a little. Then a resort was had to water measurement, and this confirmed the tale of the indicator. It would have been just as well to have stopped at what the indicator said.

Unfortunately no test was made before the jackets were put in place, and when running with "jackets off" they still formed an

excellent air jacket, without circulation. What the result would have been with no jacket at all was never known. The only fact arrived at was that circulating the hot gases from the front end around the cylinders effected no saving.

Still later, Henry Waterman, formerly master mechanic of the Hudson River R. R., who was too well known among railroad men to require further introduction, invented—he was always inventing something—a valve that was to improve the short fronted engines of the B. & A. R. R.

Waterman had written an article for the *Scientific American Supplement*, commendatory of the short front system, and now proposed to improve it by a double-ported admission, which, as I remember, differed quite materially from the Allen system of double ports.

Waterman applied his valve to an engine on the B. & A. that was used to lug freight up the hill from Greenbush to Chatham, and, although the speed, at least on our trial, never exceeded fifteen miles per hour, the indicator showed that the initial pressure was scarcely more than one-half the boiler pressure.

Waterman doubted the indicator, so a few days later he mounted a steam gauge in its place, and went over the trip thus equipped; he wanted to show that the indicator was wrong, and that his valve admitted steam at about boiler pressure. It is hardly necessary to say that he did not succeed, and it is only fair to say that he went somewhat out of his way one day to admit that the indicator, so far as he could discover, was right.

The Richards indicator, all the way through from ten to sixty miles per hour, had stood the test. I venture to submit three diagrams taken with it from a passenger locomotive, and which it happens have been preserved. They are shown in Figs. 5, 6 and 7. They show pretty clearly what kind of work the Richards instrument was capable of. They were taken years ago when speed was not so high as at present, as has been previously referred to. But mile for mile, there need not be much hesitancy in comparing them with more modern practice. If the editor prefers to reduce the size of these diagrams for publication he will undoubtedly state the amount of the reduction, as I want to call attention to the generous proportion of the diagrams as well as to the smooth lines.* The engine was 16 by 24 inches, the valves being a modification of the regular slide by which double exhaust ports were provided, but just what the construction was, escapes my memory. However, the intention is only to call attention to the character of the diagrams.

This is by no means in the way of recommending the Richards indicator. It has had its day. There is plenty of work done with the more modern instrument that the Richards indicator would not be fit for, and besides, revolution for revolution, as compared with many high-speed engines, the locomotive is easy on the indicator. I should, however, like to pay a tribute to the work of Mr. Charles B. Richards, to whom more is due than to any other single individual, for pointing out the way for improving the steam engine indicator.

* * *

THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—6.

THEO. F. SCHEFFLER, JR.

CROSSHEADS.

The design of crosshead is the well known solid box form with brass gibs for adjustment. The gibs are very wide and long to prevent any tendency to rock while in position and under pressure, the length of gibs being in all cases equal to the diameter of cylinder. Referring to the drawing, Fig. 33 is a side elevation, Fig. 34 an end view, and Fig. 35 a plan view. The gibs are adjusted by turning the nuts A A. After the adjustment has been made, the bolts *b b* should be screwed up tight against the crosshead; this prevents any vibration of gibs at center of crosshead. The gibs are easily removed while crosshead is in place without disengaging connecting-rod. They can be adjusted very closely and accurate, and they are always under the control of the engineer. The piston-rod is screwed into crosshead the same as into piston, only all the way; but in this case is locked and held firmly by means of a jam-nut, an arrangement which experience has proved to be the best in every respect, particularly as it admits of very careful adjustment of the clearance. The wrist-pin is made of the best selected hammered steel, carefully turned, and should be ground to fit crosshead. Where the pin fits into crosshead it is turned tapering 2 inches to the foot. The crosshead is made with a tongue 1¾ inches wide and ⅜ inch deep, where it fits into gibs on either side, to prevent any side motion and to keep the gibs at all times in perfect alignment with center of slides; and as the slides or guides are bored at the same time that the end of bed is faced off, we obtain absolute and perfect alignment. The crosshead is made of cast iron and should be 1⅛ inches thick at side walls; if it is made of cast steel this can be reduced to ¾ inch, but for a good desirable crosshead cast iron is just as good when made 1⅛ inch thick for this size engine.

We will now calculate the diameter of crosshead pin. It has been customary with the writer to make the diameter of pin one and one-third times that of the piston-rod diameter plus ⅜ inch; therefore, as the diameter of piston-rod is 2⅝ inches, multiplying by 1.3 gives 3.41 and adding ⅜ inch gives 3.785 inches for diameter of pin; this would be called 3¾ inches diameter and makes a good generous bearing for connecting-rod. The length of pin should be 1.7 times the diameter of piston-rod, which gives $2.625 \times 1.7 = 4.46$ inches; this would be called 4½ inches. The allowable pressure per square inch of projected area of crosshead pin is from 1,200 to 1,600 pounds. To find the maximum pressure on crosshead pin per square inch, divide the total pressure on connecting-rod by projected area of pin. To find projected area of pin multiply diameter of pin by length; therefore $3\frac{3}{4} \times 4\frac{1}{2} = 16.875$ square inches. As the total pressure on connecting-rod is 25,125 pounds from steam at 125 pounds per square inch, and dividing 25,125 by 16.875 gives 1,489 pounds pressure per square inch on crosshead pin; this pressure will be somewhat increased, due to the angularity of connecting-rod when crosshead is in center of its stroke, but this is very slight. To determine this pressure we will apply the following formula:

Let S = the total steam pressure upon the piston-head in pounds.
" S_2 = the stress upon the connecting-rod in pounds.
" l = the length of connecting-rod in inches.
" r = the radius of the crank.
" $n = \frac{l}{r}$ = the ratio of the length of the connecting rod to the crank.

therefore,

$$S_2 = S \frac{n}{\sqrt{n^2 - 1}}$$

Let S = 25125
" l = 72
" r = 12
" $n = \frac{72}{12} = 6$

then

$$S_2 = 25125 \frac{6}{\sqrt{36-1}} = 25476.75 \text{ pounds}$$

maximum pressure on connecting-rod; deducting 25125 from 25476.75 gives the difference of pressure due to the angularity of connecting-rod, which is 351.75 pounds; and dividing this by 16.87 gives 20.8 pounds additional pressure per square inch for projected area of crosshead pin; adding 20.8 to 1489 gives 1509.8 for total pressure on pin per square inch; we are practically 100 pounds inside of the limit of pressure on crosshead pin. We will now calculate the total thrust on crosshead slides, when the piston is in center of stroke, assuming we have full initial pressure at one-half cut-off, applying the following formula:

Let Q = thrust on slides.
" P = total pressure on piston.
" S = stroke in inches.
" L = length of connecting-rod in inches.

therefore,

$$Q = \frac{P S}{\sqrt{4 L^2 - S^2}}$$

Let P = 25125
" S = 24
" L = 72

then

$$Q = \frac{25126 \times 24}{\sqrt{4 \times 5184 - 576}} = \frac{603000}{141.8} = 4252.4$$

pounds thrust on slides, not including weight of crosshead or connecting-rod. By referring back to November number of MACHINERY it will be noticed that this pressure is the same as upward thrust on pillow-block cap, but calculated by a different formula. The pressure per square inch allowable on crosshead wearing surface should not be over 50 pounds for maximum pressure; 35 pounds is desirable in high-speed engines. As the length of crosshead gib is 16 inches, and width 6 inches, and multiplying $16 \times 6 = 96$ square inches of wearing surface, and dividing

* The diagrams are just half the original length.—[ED.

4252.4 by 96, gives 44.2 pounds pressure on each square inch of wearing surface, which is safe. It is now necessary to calculate the amount of horse power expended in moving crosshead on slides with friction taken into consideration. It is essential to know the weight of crosshead with one-half the weight of piston-rod (the other half of rod was estimated with weight of piston);

Fig. 33.

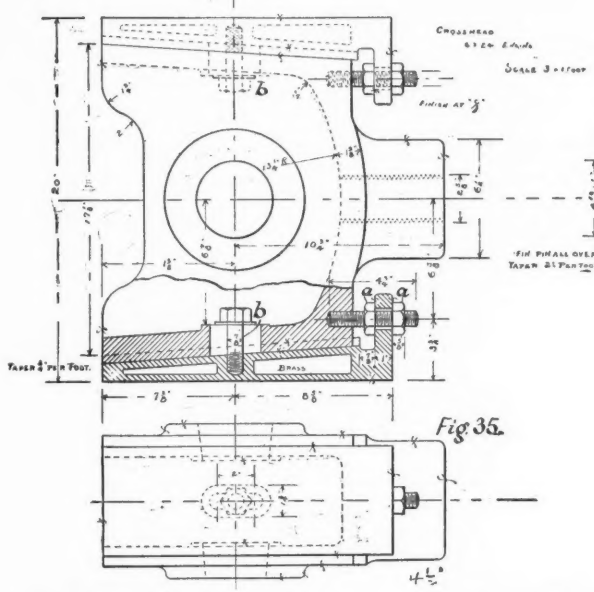


Fig. 34.

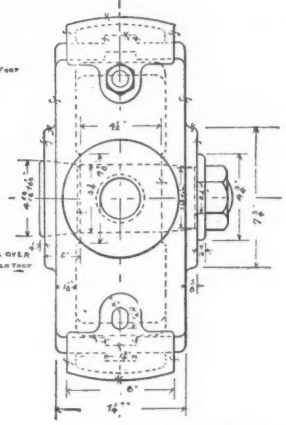


Fig. 35.

one-half of piston-rod weighs 42.39 pounds. The crosshead contains 908.9 cubic inches of cast iron, and multiplying by .26 weight of one cubic inch, gives 236.31 pounds for cast iron. The gibs contain together 312.4 cubic inches of brass, and multiplying by .3, weight of one cubic inch of brass approximately gives 93.72 pounds for brass. The crosshead wrist-pin and nut weigh together 32.4 pounds; one-half of connecting-rod weighs 110 pounds approximately on small end. The previous calculations of horse power absorbed by friction have been based on 125 pounds initial steam pressure and ⅓ cut-off; it will therefore be necessary to calculate the average thrust on piston at 81 pounds per square inch. This is done in order to obtain a uniform pressure throughout the stroke. It is necessary then to figure thrust on slides at three different points, and then take the average. For illustration see Figs. 36, 37 and 58. We will first calculate the thrust as drawn in Figs. 37, with crosshead in center, using previous formula.

Fig. 36.

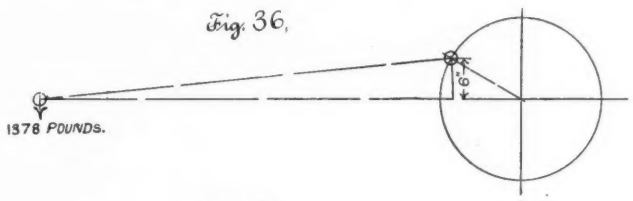


Fig. 37.

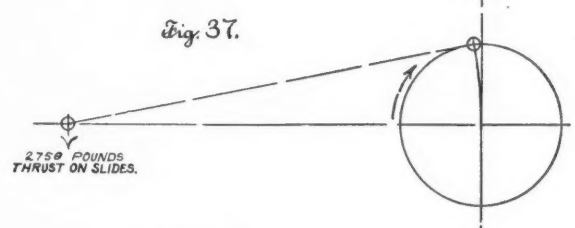
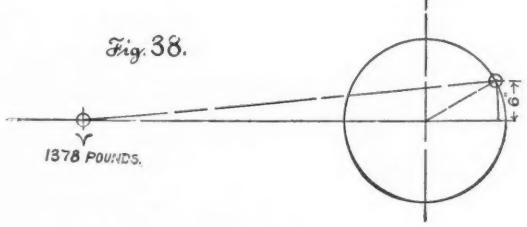


Fig. 38.



$$= \frac{P\,S}{\sqrt{4\,L^2 - S^2}}$$

Let P=16285.8 at 81 pounds per square inch
" S=24
" L=72

then

$$Q = \frac{16285.8 + 24}{\sqrt{4 \times 5184 - 576}} = \frac{390859}{141.8} = 27_{\text{?}}$$

pounds pressure on slides at ½ stroke. The pressure as figured from Figs. 36 and 38, with crank-pin 6 inches above center line of engine, will be just one-half of 2756, which is 1378 pounds for each position; and adding up we have a total of 5512 pounds; and to find the average thrust throughout length of stroke divide by 3, which gives 1,837 pounds approximately. It is now necessary to add the weight of crosshead and connecting-rod, etc., to above weights:

	Pounds.
Weight of piston-rod (one-half) =	42.39
" " crosshead =	236.31
" " brass gibs =	93.72
" " connecting-rod (one-half) =	110.00
thrust on slides =	1837.00
Total thrust on slides at ⅓ cut-off =	2319 42

We will now calculate the horse power absorbed by friction of crosshead moving on slides from the following formula:

Let H_1 = the horse power absorbed,
" f = the co-efficient of friction between the two surfaces,
Let V = velocity of crosshead in feet per minute,
" W = the load or pressure on slides in pounds,
therefore,

$$H_1 = \frac{f\,W\,V}{33000}$$

Let f = .07 { In previous calculations, f was figured at .15 on account of lubrication being uncertain when oiling valves, etc., but in this case lubrication is uniform and steady.

" W = 2319.42
" V = 680
then

$$H_1 = \frac{.07 \times 2319.42 \times 680}{33000} = 3.34$$

horse power required to move crosshead continuously at one-third cut off. We will now calculate the percentum of power expended in moving crosshead.

Let P = percentum of power.
" H_1 = horse power absorbed by crosshead,
" 100 = constant representing 100 per cent.,
" H = horse power of engine,
therefore,

$$P = \frac{100 \times H_1}{H}$$

Let H_1 = 3.34,
" H = 335.58 H. P. at one-third cut-off,

$$P = \frac{100 \times 3.34}{335.58} = .99$$

per cent. of total horse power, which is comparatively small, but in actual practice will be somewhat larger. A few more words in conclusion of crosshead: the diameter of stud for adjusting gibs should be ¾ inch, and the diameter of bolt for holding gibs rigidly against crosshead after adjustment has been made should be ⅞ inch; diameter of hub for screwing piston-rod into should be about double the diameter of piston-rod; the taper of crosshead and gibs should be ¾ inch per foot; this will allow for ⅛ inch wear on each gib. This crosshead finished all over on the outside makes a fine appearance when connected up to connecting-rod.

* * *

MR. H. M. NORRIS, who will be recognized as one of our contributors, has severed his connection with the Appleton Manufacturing Co. as superintendent and mechanical engineer, to become president and mechanical engineer of the Norris Machine Co., 29th and Jefferson Sts., Phila., who are making a specialty of grinding and polishing machinery. His experience in this class of machinery assures success for the new company.

EUGENE L. MAXWELL.

Many friends of the late Eugene L. Maxwell met on February 12 to pay their last respects to his memory. Mr. Maxwell was widely known as a member of the firms of Manning, Maxwell & Moore, Pond Machine Tool Co., Ashcroft Mfg. Co , and in connection with other mechanical enterprises. His death at the age of forty-four removes a genial and energetic worker from the ranks of the machinery trade.

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The edition of MACHINERY for March, 1895, is **15,247** copies.

Sworn to before me this 23d day of February, 1895. DAVID M. MALONEY, FOREMAN OF THE INDUSTRIAL PRESS.

CHARLES W. GRIFFITH, NOTARY PUBLIC.

All issues previous to February are out of print.

MARCH, 1895.

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WE have many orders daily for back numbers of MACHINERY, which we regret to say we cannot fill, as all editions preceding February are exhausted. We set aside 1000 copies of each month, which we thought would be sufficient, but they have all been sold.

METHODS OF DRIVING MACHINERY.

There is a growing tendency to regard the use of long lines of shafting for transmitting power to the various machines as hardly abreast of the times, and yet the solution of the problem is by no means an easy task. Theoretically there is no difficulty in solving the problem by putting an independent motor on each tool, but this is at present impracticable from a commercial standpoint. The problem in brief is to do away with line shafting which consumes power regardless of work being performed, to be able to use any machine at will, entirely independent of every other machine, and using power just in proportion to the work done, including of course a saving in cost of operation over present methods, conveniences and first cost being considered. While there are several shops using electric motors in this manner, it is to be regretted that so little actual information can be obtained concerning the cost of operation as compared with the out-of-date, but very useful line shafts which must still be depended on. Considerable has been written on this work, and pamphlets have been issued which show the advantages of the system; but when shop managers apply for estimates of cost of running and other definite information that must be well considered before making such a change as the abolition of line shafting involves, the necessary data and guarantees cannot readily be obtained. We know of several instances where this change has been or is being seriously considered, and if the desired information could be obtained and prove satisfactory, the adoption of electric motors in various parts of the shop would immediately follow. We will not go into details as to the advisability of grouping light machines to be driven by one motor, or of putting independent motors on each machine, although this depends upon the size of machines and other circumstances, but the main thing is to secure a definite idea of cost of operation, as well as first cost, because few shop managers care to make such costly experiments with so much uncertainty as to results. We believe this system is coming, and hope to see the many obstacles removed which prevent its immediate adoption.

* * *

SOUND MONEY.

Prosperity will not return to this country until the currency question is settled, and every man who is affected by the present condition of business—the artisan in the shop no less than the manufacturer in the counting-room—should use his voice, his influence, and his vote in favor of sound money. Divested of all the verbiage thrown around it by theorists and cranks, the naked fact remains that gold is the standard of value of the world over. The value of a silver dollar, of a greenback, of a Government bond, is determined by no standard save the ability of the Government to pay its value *in gold*. When that ability is questioned the value of all securities fall, and following them the value of all merchandise shrinks, business stagnates and the workingman goes without employment. This has been abundantly demonstrated during the past three months.

This country cannot exist in commercial independence of other nations, nor can we force them to apply our standard to their currency; and until a relative value of silver to gold shall be agreed upon by the commercial nations of the world, we must accept the present standard and adapt our transactions to it, or suffer from the efforts of those mistaken theorists who would place the country upon a fluctuating silver basis.

* * *

THE PREMIUM PLAN.

This in brief consists in giving the employees a portion of all they can save over a given amount of material. The

plan is being tried to some extent in shops, engine and boiler rooms, and to a much greater extent in railroad service, with almost uniformly good results; and it has many advantages and few drawbacks, where it can be applied. Locomotive and stationary engineering afford excellent fields for this method, and it can be tested without any change of men or apparatus, as the only requirement is sufficient time to carefully observe the average consumption of coal, and consequently of water in most cases, so as to establish a figure to work from. An incentive is thus offered for increasing the economy of any plant, to the pecuniary advantage of both parties, as the saving is usually divided between employer and employee. When the engineer realizes that every leaky joint with its small cloud of escaping steam is keeping money out of his pocket, he takes pains to remedy the defect, and there are many other points which afford an outlet for dimes and dollars in a similar manner. A little more care may save a ton of coal a week, and besides putting a dollar into his pocket he also has that much less shovelling to do. This idea is applied to shops in a less degree, the saving usually being effected in time rather than in material, but being no less profitable to both parties. There is little difficulty in finding some department or line of work where this method can be introduced, and if care is taken we are sure it will be extended rather than curtailed.

* * *

THE PITCH AND STRENGTH OF GEAR TEETH.

SAMUEL WEBBER.

In MACHINERY for December, 1894, I find the following query, signed "Whynot": "Why not adopt the plan of using diametral pitch until 'one' is reached, then use circumferential pitch?"

It is a good many years since I graduated from the shop, and the term "diametral pitch" has come into use since my working days, and I am free to confess, that probably owing to stupidity on my part, it conveys no meaning to my comprehension It may be a convenient "shop term," by which to hunt up a gear of the proper number of teeth, by which to transmit the same, or a relative velocity if simple *motion* is the only thing to be transmitted, but if the power to be transmitted by each tooth is the point in question, as it is usually with large gears, and sometimes with small ones, the diameter must be multiplied by 3.1416, and the thickness of the tooth at pitch line ascertained in order to determine the power which any tooth, or pitch, will transmit with safety at a given velocity.

The writer has had occasion to wrestle with this problem of the thickness or pitch of teeth, twice within the last dozen years, and the last time, some five years ago, he published in the *Journal of the Franklin Institute* a paper giving the result of his investigations into the laws governing the strength of gear teeth, with a table of the power which might be safely relied upon to be transmitted, by gears of various pitch and at different velocities. As many of your readers may never have seen this paper, and as it shows the circumferencial pitch to be the only real element of importance in the transmission of *power*, not of velocity, it may be pardonable for me to recall this paper, with some of its data and conclusions, for the benefit of some of the younger mechanics.

The writer has long had among his memoranda several rules for the proportion of gear teeth, which, as they are all very old, may have been modified somewhat by later mechanics, but which he will copy as he has them; the first, a very old English rule, of which he has forgotten the origin; the second, one as given him by Prof. Willis, in England, in 1851; and the third, one obtained long since from the Lowell machine shop.

	Old English.	Prof. Willis.	Lowell.
Pitch of tooth	1.00	1.00	1.00
Length of tooth	0.75	0.70	0.60
Working of tooth	0.70	0.60	(?)
Clearance	0.05	0.10	1/8 in.
Thickness at p. line	0.45	0.4545	11/25 p.
Space at p. line	0.55	0.5455	14/25 p.
Width	2.50	2.50	2.50

I am not quite sure now about the length of the Lowell tooth, but think the 0.60 must have been the *working* depth, to which the clearance was to be added.

Now these rules all date from the old days of cast gears, and it may be that modern practice has reduced the length of the tooth, for it certainly seems that with modern cut gears a length of 0.50, or ½ the pitch, with a clearance of 0.5, or $\frac{1}{20}$ pitch, should be ample if the gears were well supported in their bearings, so that any spring in the shaft would not reduce the contact.

Such shortening of the tooth might permit a wider base, giving greater strength, as the bottom of the tooth would not need to be cut away so much to allow for the sweep of point of the opposing tooth, which might also be cut away more above the pitch line than is the usual custom, the base of the tooth being its weak point on which the leverage is exerted.

The tooth of a gear is simply a lever, acting under the laws which govern a beam, firmly fixed at one end and loaded at the other, the "other end" in this being supposed to be the pitch line, although there is always a certain amount of strain on the point of each tooth during its revolution. Still, as this strain on the point in properly cut involute or epicycloidal gears only occurs when another tooth is in position to take the main load at the pitch line, and is also in such a diagonal direction that the tooth offers a stronger resistance, it need not be taken into account, and the pitch line may be considered as the point from which the leverage is to be calculated.

The writer has said that he has had occasion twice within a few years to make the calculations by which to get the necessary thickness of tooth to transmit a given power, and as these two cases varied very widely, he will briefly state them.

One was for a pair of gears for a dynamometer, 12 inches diameter, to transmit 1 horse power per each 100 revolutions per minute, and to be run at speeds varying from 100 to 1,500 revolutions per minute, with a pair of bevels 6 inches diameter outside, to transmit same power at the same number of revolutions.

The other case was for a pair of gears to transmit about 600 horse power at 2,000 feet per minute, or the smaller gear, 4 feet diameter, at 165 revolutions per minute. I had to find the same general law to cover both cases, and the discrepancy in the rules I found and my analysis of them, formed the paper for the *Franklin Institute Journal*, of which I will only refer to the salient points now, as the full article can no doubt be easily obtained by any one who wishes to go through with the matter.

The first question I practically solved by a rule given me by my old friend the late James B. Francis, that the thickness of the tooth might be taken as = ∜ pressure in pounds × .020. Now, as h. p. = 33,000 pounds raised 1 foot per minute, and the circumference of a 12 inch gear moved 314.16 feet per minute at 100 revolutions, then the pressure was = $\frac{33000}{314.16}$, or 105. The square root of this is 10.267, which multiplied by .020 gave .205 inches, and if the thickness is $\frac{5}{11}$ of the pitch, then the pitch will be .45 inches. This on a 12 inch gear would give 83.75 teeth, so I made it 84 teeth, as 3 would always be in contact at once.

I was not satisfied without getting more nearly the root of the matter, and taking up a paper published by my friend Mr. John H. Cooper, in the *Journal of the Franklin Institute* for 1879, I found a collection of rules which he had made and worked out to their conclusions, varying from the formula of Bolton & Watt, of 66.17 h. p. for a tooth of 3 inch pitch, at 15.708 feet per second, to that of Nystrom, in 1875, of 259.95 h. p. for the same pitch and speed, but based on the contact of 2 teeth at the same time. Jones & Laughlin gave from a different formula, based on 1 tooth, 147.27 h. p. Haswell gave two rules, one a little more and one a little less than Jones & Laughlin.

All these formulæ were of course based on the strength of iron, which Boulton & Watt took at 7,200 h. p for a beam 1 inch square and 1 inch long, loaded at one end. They assumed one-third of

this, or 2,400 pounds, as the elastic limit, and one-fifth of *that*, or 480 pounds, as the safe strain.

Looking over a series of tests of American iron, published by Mr. Thomas D. West, in the *American Machinist*, I have thought it safe to assume 8,000 pounds as the breaking strain of such iron, and 500 pounds as the safe strain per square inch.

Then

$$500 \frac{\text{feet } t^2}{6}$$

will be the safe load at the pitch line, by established rule.

I will not take up space by repeating the calculations by which from this basis I arrived at the formula, h. p. = vel. in feet per second × 5 × the square of the thickness, or h. p. = (v 5 t^2), which is very near Haswell's (v t^2 5.45), and comes out very near Jones & Laughlin's,

$$\frac{(p\ d''\ f\ n)}{550}$$

in which d'' is diameter in inches and n is number of revolutions per minute, and which gives a result just one-half of Nystrom's "2 tooth" formula of

$$H = \frac{t.\ f.\ v}{55.}$$

They all evidently worked from nearly the same basis.

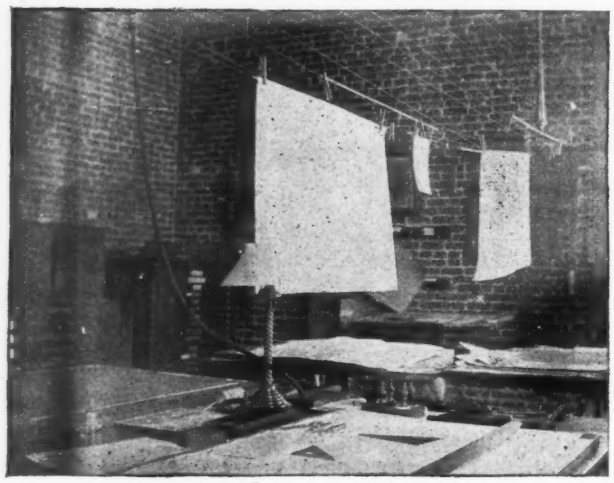
I will merely say that this formula applied to my first question, and gave me a thickness of tooth of .195 inch, instead of .205 by Mr. Francis's rule, and on submitting it to him he pronounced it amply satisfactory. Applied to the larger question it gave me a thickness of tooth of 1.897 inches, or a pitch of 4⅛ inch. This on my 4 foot gear called for 36.6 teeth, but as I knew I was amply strong, and wanted an odd number of teeth, I made it 37 teeth. The dynamometer, built from the first calculation, has been run a dozen years without accident, giving from ⅛ h. p. to 16 h. p., according to velocity.

I do not know how I could have got at this from any table of diametral pitch.

* * *

AMONG THE SHOPS.

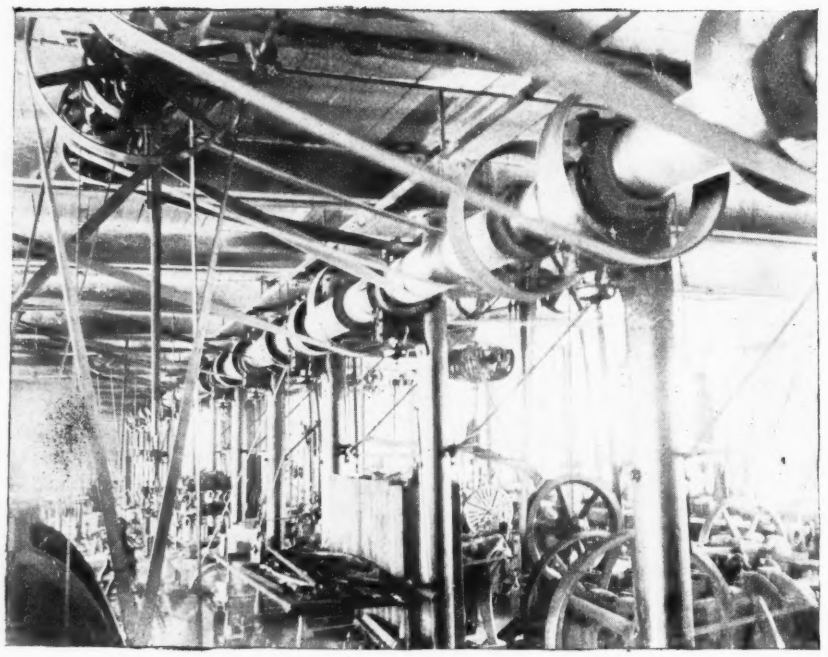
A VERY handy feature for the drawing room is shown by the photograph taken in the drawing room of the Wheelock Engine Co., Worcester, Mass., and introduced by their chief draughtsman, Mr. Chas. H. Jenness. It consists of wires stretched about 4 feet above the drawing tables, for holding tracings or blue prints when needed for comparison on consultation. Spring



A METHOD OF HOLDING TRACINGS.

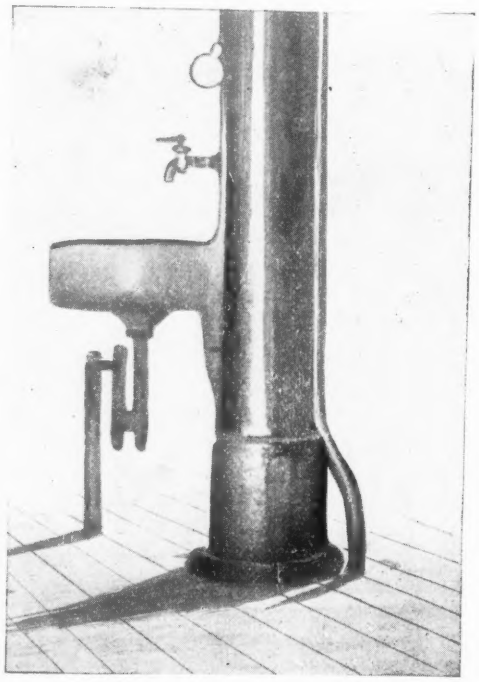
clothes-pins are placed over the wire and hold the tracings as shown, which can be shifted from table to table or can be moved aside to consult those behind it. Altogether it is a very handy arrangement and much more convenient than having two or three tracings lying around the drawing table, to consult as occasion requires.

PROBABLY a great many mechanics have heard of the peculiar shafting arrangement in the Colt Armory, at Hartford, Conn., and a view of a line of this shaft taken in the portion occupied by Mr. Asa S. Cook, may be of interest. It will be noticed that the round cast iron columns have projections cast on the side to which the side hangers carrying the shafting are bolted. The shaft is in reality a series of cast iron shells or drums, 12 inches in diameter and about 8 feet long, being reduced at the bearings to about 5 inches in diameter. These shells are said to be about an inch thick and consequently weigh about 100 pounds to the foot, and as there are 3,500 feet of t through the shops the friction load on the engine can be imagined. The object in designing this was to obviate pulleys and to be able to put a belt anywhere you pleased, without the trouble of putting on pulleys (this was before the days of split pulleys), but the demand for higher belt speed has necessitated the addition of large pulleys, as shown. The main shaft is driven direct by two vertical Porter-Allen engines, built in place, between cast iron columns, and runs about 130 turns a minute.



HOLLLOW CAST IRON SHAFTING.

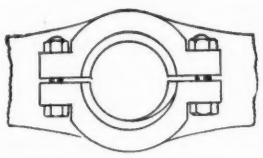
ANOTHER feature in the same shop is the system of wash-tanks, fastened to the same columns as the shafting (though somewhat nearer the floor), and while nothing especially attractive, they show the study that must have been made to have a complete shop system quite a number of years ago. The one special feature is the trap under the wash tanks, which is made of tees and nipples, with caps in tees so as to admit of ready cleaning in case of stoppage, as will occur sometimes.



AN OLD WASH TANK.

THERE is quite a novel plan in use at Gould & Eberhardt's foundry, which has a tendency to prevent bad castings by pure moral suasion. On a convenient wall is painted the weight of bad castings returned during the month, and every one can see whether the record improves or not.

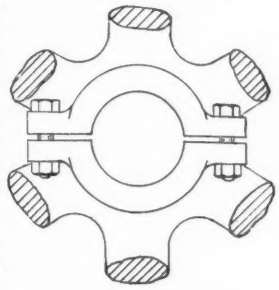
Among the features recently seen in the shop of the Altoona Mfg. Co. were several of general interest, the testing bed, where all engines are set up and run at the the desired speed, being one of the things too often neglected by high-speed engine builders. This is made of four long slotted beams set in cement on a solid foundation, four feet apart, and fitted for T-head bolts, making it an easy matter to fasten any size engine solidly on a good foundation.



The boring mill, as usually constructed, was added to by another boring bar set at right angles to the main bar, by which a small engine frame could be placed on the mill and the cylinder and shaft bearings bored at one setting.

A good plan, though not entirely new is adopted for the fastening of cross-heads on the piston-rods and the fly-wheels on the shaft.

The cross-heads are cast split and then wedged slightly apart, to be bored and threaded for the piston-rod. This gives a good grip on the rod even without the bolts shown, which are used as a further check against loosening. The good feature of the threaded rod adjustment is retained without the strain of the jam-nut on the rod, and the rod destroying key is also avoided. For fly-wheels the hub is split as shown, and serves two purposes, the relieving of internal strain in the hub of the casting and the solid fastening of the wheel to the shaft, as by wedging the hub sufficiently to permit sliding on shaft, the bolts have little to do and the key prevents turning, making a good mechanical construction and one which is not very expensive. This, of course, is not applicable to very large wheels, but for such as are used in high-speed engine work it seems to work admirably.



* * *

FINDING SQUEAKS AND KNOCKS IN MACHINERY.

John H. Cooper.

I once sent a boy to find a squeak in a lathe counter-shaft; he returned to me, saying he could not find it. I asked him whether he used his eyes or his ears to hear with. Not understanding me exactly, I then said to him: "Let us go and see if we can find a pulley that makes the same number of turns per minute as the squeaks we hear." We soon found one. "Do you see that?" pointing to the desired pulley; "Yes, sir," he replied. "Now step up to it and oil its shaft." He did so, and silenced the squeak.

"Let me now impress this upon your mind so that you will remember it as a lesson well learned. In future, when you are sent to find a machine shop squeak, be sure to use your *eyes* as your *ears*."

This little incident, which happened forty years ago, I have turned to good account many times since.

Knocks in engines can be found very easily in the same way, by synchronizing the sight and sound of them. Every one knows that the sounds of working machinery are carried to almost every fixed and working part of the same, and unless there are some means known of locating them by coincidence of motion their discovery is very difficult.

The fact is generally observed that sounds are loudest where they are made, but we cannot always say, in truth, that sounds gradually decrease in loudness as we withdraw from the sounding body; surrounding objects may have the effect of dispersing or concentrating the waves of air, which carry sounds, so to speak.

A concave body will collect the promiscuous sound waves about us, rendering them audible, which, without some special device, would pass by us unheard. So children say: "Put a sea-shell to your ear and hear the ocean roar."

In the philosophy of echoes the existence of surfaces which collect and return to us the expanding sound waves are included, but we are at or near the focus of these rays in order to get the benefit of the many vibrations, which, without concentration, would be lost to us.

The increase of sound in one locality and its decrease in another diverts the attention, confuses the ear and makes the locating of its origin difficult in the engine room; therefore it is necessary for the ear to have the aid of the unerring eye to fix the exact place of it and find the cause.

I have often proved the necessity of *seeing* as a strong aid to *hearing*, by pacing back and forth many times the full length of the engine, as a method of locating a "thump," often finding little or no difference in the loudness of the sound, wherever I might be, but as soon as I discovered a concordance of sound and motion, then at once the solution came—there was no uncertainty afterwards. So Shelling says: "In order to see aright one must know to look."

The study of acoustics and its illusions is deeply interesting by the peculiar phenomena presented and the startling disclosures made. The flight of sounds, followed by their repetition without apparent cause, as with echoes, and their diversion from original sources, completely deceiving the listener, as shown by the art of the ventriloquist, are familiar and eloquent examples of the extraordinary behavior of sounds, which prove the necessity of aiding the ear in order to obtain correct knowledge.

The noises of the engine room swell and fade away and come again as if by magic, putting you all out in your search for their source.

Of course we do know that knocks in engines are as numerous in variety as the engines themselves, and that they arise from many more sources than the numbers and handling of the same. One prime source of knocking is want of alignment; for, say what we will, an engine in motion under steam is in a very different condition, with regard to its lines, from the same engine when standing. Under severe and reversed strains, every part yielding more or less to the pressure imposed, the certainty of maintained alignment is not secured, and the extent of the departure of some essential organs of the power transmission while at work, from the mathematical exactness intended, is not known till the engine speaks in tones which the intelligent engineer ought to understand and answer.

Heavy oil and oil with pulverized and purified graphite, will often cushion the bearing and cure a mild knock in shafts which are acted upon by reciprocating forces. Sliding pieces of machinery frequenty knock after long use, when a change of its stroke has been made by adjustment of connected parts; a shoulder has been formed and the moving part strikes it. The amount of metal in the way is often astonishingly small, as I have found by experience in cross-head guides and steam cylinders.

The ways of some knocks are well nigh past finding out, deceiving and defying the very elect.

I had a case of knock in a vertical engine once that outwitted two of our best machinists. They both took the engine completely down and re-erected it, but failed to find the cause of the knock. A bystander declared the follower of the piston was loose, for he had a long hunt in his engine and found the knock at last, as he stated; therefore, it must be in the piston. But, my dear sir, there is no follower to this piston, it is a solid one with rings sprung into its peripheral grooves. Another informed me that after diligent search everywhere, as he thought, he finally discovered the crank-pin to be loose in the crank—impossible of application to our case. This engine shaft has a solid forged center crank, all in one piece. Other causes were discussed and explained away; there was certainly no precedent for the knock we had in hand.

So dismissing all critics and adjusting properly all the working parts, "Now, John," I said, "let's see her run." And sure enough, there was that same unvanquished knock, occurring every time the cranks passed the top tenter. "Now, John, run her slow—as slow as you can." We now have two knocks instead of one, at the same place in the turn.

Here is something to reason out: two knocks at slow speed, one at high. What part of an engine can do that? It must be at the place where the parts under the intermitting action of the steam join the continuous running wheel; for at high speed the wheel does not outrun the shaft, but the steam is quicker than the wheel and turns the shaft ahead, pressing it against the key; in the other case, when the engine creeps, the crank will hardly pass the top center without help; but the wheel, being heavy, keeps on in rotation, crowding the key and driving the shaft over the top center; when the steam comes on it sends the shaft quickly ahead, pressing against the other side of the key. Now, if the key is not tight, these knocks can be accounted for. This

mystery being cleared up, I tell John what's the matter: the fly-wheel key is loose. "Stop the engine and hit the key a tap with your hammer, please." And when we started again a quieter running engine was never seen.

You sympathize with the long-suffering engine-driver who for months can't trace the "knock" to its source and silence it He comforts you with his justifiable (?) remark that it has been in the engine from the first. *You*, mayhap the busy engine-builder, step in on call, hear the knock on moment of opening the door of his engine room; take up a wrench from the window sill, give a tap-bolt on the cross-head a slight twist, throttling the said knock, bid the engine room good-bye and pass out and down the street, wondering whether it is or is not included in the curriculum of the engine-man's studies and duties to seek for and to gain and to apply some knowledge of knocks—their cause and their remedy.

* * *

A NEW EMERY GRINDER.

The details of this machine are very interesting to the machine designer and particularly to the user, as the cost of production has been brought to a very low point. The spindles are unusually stiff, and provided with extra long bearings, three diameters in length, well protected by dust caps, as shown. The sizes of spindles, as well as every other part throughout the entire family, vary in the ratio suggested in the article by the designer, Mr. H. M. Norris, in a recent issue of MACHINERY. The boxes are self-aligning, being spherical in shape and held in place by the cap as shown. The boxes are split on the back side, away from the dust, and the taper screws shown in the slot adjust the bearing as desired. The distance between boxes is greater than usual, and the spindle length is distributed where it will do good service instead of being all overhang, as is sometimes the case. The grinding rests are very simple and effective, the number of joints being reduced to a minimum, and so designed as to be easily and cheaply made. These allow every necessary adjustment and can be firmly held in any desired position. The machines have large rectangular bases and may be mounted on either bench or column. The sizes vary from an 8 inch to a 14 inch wheel, width of face from 1 to 2½ inches, and speeds from 2,400 to 1,200 revolutions per minute, making a very complete line of small grinders, with extreme simplicity of design and great efficiency their leading feature. They are made by the Norris Machine Co , 29th and Jefferson streets, Philadelphia, Pa., to whom inquiries should be addressed.

* * *

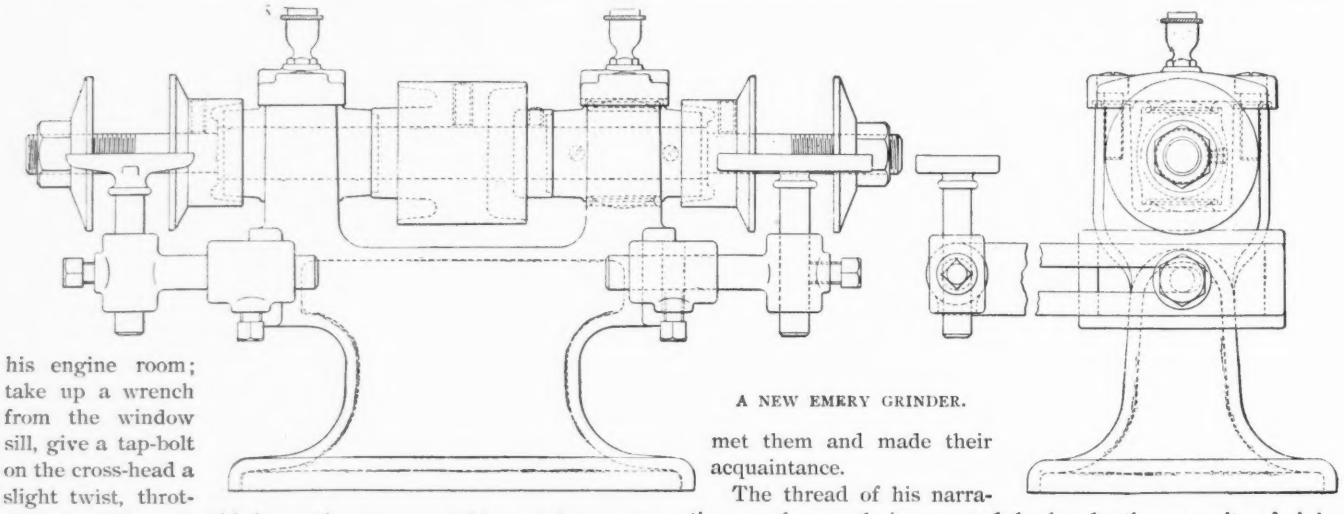
A NEW SURFACE GRINDER.

The finishing of surfaces by grinding has grown into such favor that new machines are being constantly devised for better performing this work. One of the latest machines for surface work is shown in the accompanying engraving, being designed and built by Woodward & Rogers, of Hartford, Conn. The main feature of the machine is the travelling of the wheel across the work, while firmly supported in ample bearings, wearing the wheel much more evenly and increasing the range of work of the machine. Automatic feeds are provided for both table and wheel, and better work is said to be produced than with the old form of machine. The machine shown will grind a surface 14 inches wide and up to 24 inches in length, and weighing 1,200 pounds, is solid and steady, as is required for accurate and rapid work.

NOTES FROM THE WORKSHOPS.—1.

A. LEARNER.

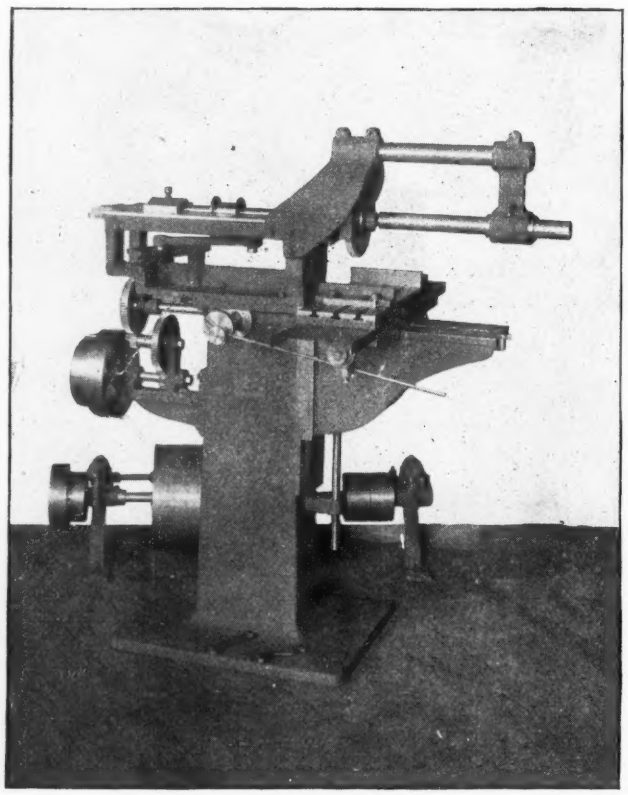
It was a busy scene, even if the times were dull; and it was some time before the attention of the proprietor (who was also superintendent and boss in the shop where they were doing first-class machine work) could be secured to respond to some questions about the origin of some kind of machinists' cutting tools, and to tell of their early history, and when and where he had first



A NEW EMERY GRINDER.

met them and made their acquaintance.

The thread of his narrative was frequently interrupted, broken by the necessity of giving orders and answering the questions of his men, and the idea came into the head of the interviewer that he ought to have a foreman under him to attend to these little affairs, minor details; but that thought was crowded out by another, quite as brilliant, which was that if the interviewer would get his information from the encyclopedias instead of bothering live men, the boss would have ample time to attend to his own details. So



A NEW SURFACE GRINDER.

he didn't make any suggestions of the kind, while the boss narrated some incidents which contained a bit of human nature, and are perhaps of interest.

"Yes, I had a very good opportunity to get acquainted with the different varieties of tools in use in my early days," he said. "When I was a kid, about 19 years old, I went into a new shop to work. I was out of my time, for I went into the shop young. The shop I learned my trade in was at Mattawan, and the class of work, that was made there before the war broke the country up

was largely for use in the Southern States. It was sugar machinery, cotton presses and the like, and when the war broke out the company had nearly half a million dollars owing to them which they could not collect.

"Full of pluck, in spite of fate, they turned their attention to other work: made guns, engines, centrifugal machines and other machinery for sugar refining; did a fine class of work; were thoroughly abreast of the times in their methods of doing work and in the use of tools, especially in the employment of the best tools for use on planers, lathes and the general tools of the machine shop.

"I found that this was a great advantage to me when I went to work in other shops which were not so well advanced, as it enabled me to introduce some tools and methods of doing work which were improvements upon the ways that they were using. In this first shop that I went to, after I was out of my time, I distinctly remember such an instance, which helped me to gain the good will of my employers.

"I was running a planer, and the man that worked at the second planer from me was foreman of the planers, and was a first rate planer hand, about as good as I ever knew; but I was able to give him a pointer once. He had a large brass cylinder to plane on the outside I don't know what it was for, but it had four wings running longitudinally the whole length. They were not set radially, but I suppose you might say "chordially," only a short distance from the top and bottom, as the cylinder laid horizontally on the side. They were probably intended to bolt the cylinder to a frame. The way the wings were set on gave them an acute angle with the body of the cylinder on one side of each, and in this angle was a fillet to make a more substantial junction.

"It was in planing out this junction that my friend Robert got into trouble, not a silent, endurable trouble at all, but a noisy, tumultuous racket, that groaned and shouted, and re-echoed all through and around the shop. His tool would go into the work and rip and tear out the fastenings and stand the platen upon end.

"Gushing over with good will I went to him, after I had watched him for a little while, for I knew what would help him out. I told him I thought I knew of a tool that would do the work without any trouble, and he said: 'Go back to your work and mind your own business.' And I said, 'I will.'

"I didn't know any better than to do just as he told me to; I was a tractable kid. I went back to my planer, attended strictly to my own business and ventured no further suggestions. But his trouble went right along with him all the same, and rather got worse. The boys got on to the racket, and every time his planer would fetch up with a jerk, something would slam down on the floor with a bang. It was so noisy that the proprietor's attention was attracted, and he came into the shop. He was just in time to be missed—missed by the end of an inch and a half planer tool, which snapped off and went whizzing by him into a post.

"He was startled, and cried out: 'What, what, Robert! Robert, what's the matter?'

"'Nothing,' said Robert, 'only I don't want to live any longer! That cussed thing's got the best of me, and I can't plane it.' 'Pshaw! pshaw! this is the first time I ever knew you to give up beat.' 'Well, I'm beat now. I wouldn't care so much about it if it wasn't for that kid, William, over there.' 'William! what about him?' 'Nothing, only I told him to mind his own business, and I guess I spoke too previous. I reckon he can plane it; he says he can, and I'd like to have him try.'

"After a few more words the proprietor called me over and asked me if I could do the job. 'Yes, sir,' I said. 'You know you can do it?' 'If I can't do it you needn't give me a cent. All I want is a piece of steel and a blacksmith to make me a tool.' 'Well, you may have any tool you want. It has to be done, and if you can do it, it will help us out.'

"I turned around to Robert and asked him if it was all right. 'Yes, you bet it's all right, and I'll be much obliged to you if you'll do it. Just go ahead. I didn't speak to you just right; I know that. If you'll just tell me where you are on your planer, I'll go ahead with your job while you are working on this.' I showed him how I had laid out the job on my planer, and he went to work on it, and I went to the blacksmith and told him the old man said he could make me a peculiar tool, as I wanted it. 'All right,' said he; 'show me what you want.' He was a regular tool dresser, one of these fellows you can make understand anything by tracing it with your finger in the air, but I made him a sketch with a piece of chalk on the forge, so that he could have a perfect drawing to go by; and he made the tool just as I wanted it. It was one of these tools that are common enough now, that are bent back so that the cutting edge is back of the back side of the shank, and so if it catches, the spring of the tool lifts it out of the cut instead of driving it in. 'That's a queer looking tool,' said the blacksmith.

"I carried the tool into the shop, ground it up, set it, and brought it down to its work. No trouble; trouble all gone. It went right along without balking. Robert came over to me after I had got it well settled down to its work and running in good shape, and spoke some very pleasant words to me. He said that the little occurrence had taught him a lesson, and that was to treat any fellow that tried to help him as one man should treat another.

"I finished my job so quickly and so well, that the proprietor expressed himself as highly gratified with it, which gave me great pleasure. Robert showed himself so much of a man that the lesson he learned forced itself also upon my mind, and I appropriated it to my own use so well that I have always been ready to accept well meant advice, or suggestion, in the same spirit in which it was tendered. There isn't one of my boys but what will come to me freely and ask me what I think of any idea he may have. They know I always treat them cordially and respectfully. Never use sarcasm in talking to a boy, they can't stand it. My boys have never been frightened by the bugbear of ridicule, and do not fear being laughed at.

"I have got a great many ideas in this way, not only directly, but indirectly, as the subjects thus started stimulated some train of thought that led to useful results. Besides that, in ransacking my brain to get information for others, I have kept some track of my stores of information, just as when a man used to go into an old fashioned pattern room and tumble over the patterns to find what he wanted; he would in that way keep up a sort of acquaintance with all those old patterns, and when the occasion required he would know whether he had what was wanted, and if he had he could tell pretty nearly where to lay his hand upon it."

* * *

MR. WILLIAM H. COLE has become a member of the well-known firm of Tower & Lyon, 95 Chambers street, N. Y. Mr. Cole has been connected with the business for a long time in a confidential capacity, and during the extended illness of Mr. Tower all the office work has fallen on his shoulders, so that his promotion to a partnership is a recognition of his meritorious services, which all his friends will appreciate.

* * *

LONG AND SHORT CONNECTIONS.

W. H. WAKEMAN.

The question as to whether we must always use short connections between our indicators and the engine cylinders or not, is one that is receiving more or less attention at the present time from several of our contemporaries, and experiments have been and are being made to determine the point. We wish to call attention to the fact that here as elsewhere it is always a good plan to try only one experiment at a time, and to give that a

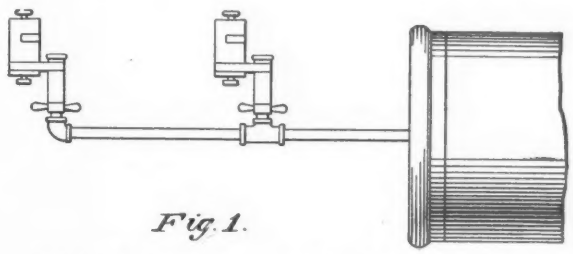


Fig. 1.

thorough trial. If more than one is tried, we do not know which to credit with the result obtained. Suppose, for instance, that we should fit up two indicators and connect them to an engine cylinder in the manner shown in Fig. 1. Here we have one near the cylinder, and another one about four feet distant, but both are on the same pipe. If we take diagrams simultaneously with these indicators, and then claim that one of them is on a short and the other on a long connection, is not our experiment open to criticism? Would not the claim be made at once that both indicators were on the same pipe? Under these conditions would they not be subject to the same pressure, and if the diagrams taken proved to be alike, is it not only what might be expected? We think that such a claim would be perfectly justifiable. If we connect two indi-

cators to an engine cylinder in the way illustrated in Fig. 2, are they not practically subject to the same conditions as in Fig. 1?

In either case the whole of the clearance, including the pipe in the long connection, must be filled with something before any pressure will be manifest on the piston of either indicator, and when any pressure does accumulate it may affect both instruments alike, and

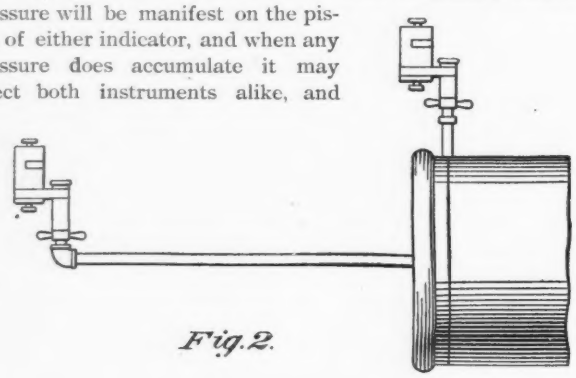


Fig. 2.

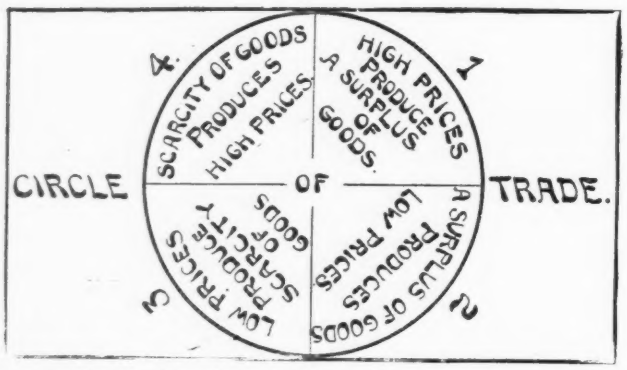
such an experiment is of no value in trying to determine the difference between long and short connections. The only proper way to do is to connect one indicator to the cylinder by the shortest possible connection and take diagrams with it. Then lengthen out the connections to any desired point, and take more diagrams, taking care to use the same reducing motion in both cases, and then make comparisons. If this is done and the long connection is kept within reasonable limits, it will be found that little or no difference will be manifest in some cases, but in others there will be a great difference. If the speed of piston is slow, the steam pipe and ports large and other conditions favorable, we shall find no difference, but if the piston speed is very high and the steam pipe no larger than would be needed for a slower speed, then the long connection will not be filled in time to cause the indicator to give a correct diagram. We have arrived at these conclusions after conducting experiments for this purpose, and therefore are not surprised to learn that different engineers have arrived at different conclusions in the matter.

Fig. 3.

We have just fitted up an engine that is to be used partly for experimental purposes, and when putting in the indicator connections we made them as shown in Fig. 3, which is a plan. There are tees located between the valves and the cylinder (not shown in cut), which look upward, into which the plain indicator-cocks will be screwed, and when the angle valves are shut it makes short connections for two indicators, but when these cocks are closed and the angle valves opened, the three-way cock in the center gives a long connection for both ends.

* * *

"WHERE ARE WE AT."



—From the circular of the Builders' Iron Foundry, Providence, R. I.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

We refer a correspondent who asked for information on the pressure on guides due to angularity of rod, to Mr. Scheffler's article in this number.—[Ed.

THE PATENT PRIVILEGE.

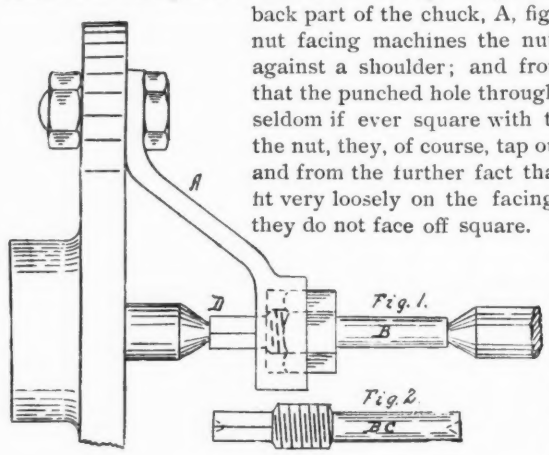
In the December number of Machinery is an article on the above subject, in which it is recommended that an inventor should have an examination made at the Patent Office, by an attorney, to see if any one has patented the same invention. The usual fee for this is five dollars, but it is often very doubtful whether it pays to have it done even at that low cost Such investigations are confined strictly to an examination of the claims as published in the *Official Gazette* of the Patent Office in the United States only, and do not extend to an examination of the specifications, because nothing but the claims are published in the *Gazette*. It sometimes happens that things are described in specifications that do not appear in the claims, but if a device or invention is once described in a specification it prevents any one else getting a patent, no matter whether it has been included in the claims or not. Thus it is evident an examination of the claims may seem to leave the way clear for a patent, but when the official examiner gets at it he may find specifications that describe a similar device. Also the fact that an examination by an attorney is confined to United States, patents only makes it of doubtful utility; for if such invention is specified or patented in any foreign country it prevents a patent in the United States. Further than this the official examination of all books, periodicals and other publications relating to the art is made, to see if it has been previously made public property. It is true that sometimes patents are allowed on inventions that are not novel, because the examinations by the official examiner were not comprehensive and searching enough, but this is the exception, and the examinations as a rule are very searching and effective.

Of course a patent attorney may, from personal knowedge and experience, be so well informed of the state of the art regarding certain lines of inventions that he could give a valuable opinion as to patentability of a device, without making a special examination, but the regular five dollar preliminary examination is not of that kind.

Bell Crank.

A NEW NUT MANDREL.

Enclosed I send sketch of a nut mandrel or arbor that will face a nut *square* with the thread. The mandrel proper is shown in B C, fig. 2. It will be noticed there is no shoulder on it. The end D is made square and fits loose through a square hole in the back part of the chuck, A, fig. 1. In all nut facing machines the nut is run up against a shoulder; and from the fact that the punched hole through the nut is seldom if ever square with the face of the nut, they, of course, tap out crooked, and from the further fact that the nuts fit very loosely on the facing mandrel, they do not face off square. The chuck is cast with a hexagon cavity to suit various sized nuts and is bolted to the face plate of the lathe. The chuck drives the mandrel and nut at the same time; the mandrel only acting as a carrier for the nut, keeping it central and square, enabling us to face the nut square with the thread. A nut faced out of square, will always bend the bolt or stud when screwed home; and is the cause of so much trouble in taking cylinder covers and other like parts off. over the studs. After nuts have been faced off with this device they can be put on an ordinary mandrel and chamfered off to suit.



A correspondent in a late number speaks of hammering a piece

of iron into a bad spot in casting, and finishing it flush. It is the same way we used to put patches in wrought-iron locomotive tires when a flat place showed up, and they were frequent. It was a hard job with the wheels under engine.

Pan Handle Shop, Indianapolis. W. de SANNO.

POWER OF SHAFT

At the bottom of page 11, in the January number of MACHINERY, there is a formula for finding the H. P. that a steel shaft will transmit, viz.:

$$\frac{D^3 \times N}{100}$$

A 2 inch shaft which I have in mind runs 200 revolutions. Then

$$\frac{2^3 \times 200}{100} = 16 \text{ H. P.}$$

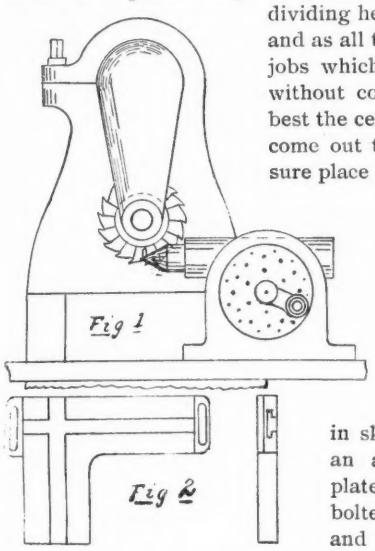
the shaft will transmit. Now about 50 feet of this shaft drives six power presses, three drops (one with 450 pound hammer), and two polishing wheels. Then an 8 inch belt carries the power to nearly 100 feet more of 2 inch shaft with same speed, and this shaft drives, besides a lot of small polishing wheels, etc., six large buffing lathes, which alone use a large part of the figured capacity of the shaft. It seems to me that this formula does not correctly represent the power which this 50 foot shaft transmits every day. Practice often disproves theory.

[The formula mentioned is based on the common assumption that a 1 inch shaft at 100 turns per minute will transmit 1 H. P., and is used by many engineers. This gives a large factor of safety.—ED.]

REPAIRING A BROKEN CENTER.

As I am much interested in your "kinks," as you call them, I will send you one of mine, although it may be old to some, but it was new to me, for I had never heard or seen anything of the kind done before.

In the first place the point got broken off the center in the dividing head of my milling machine, and as all the lathes were set up for jobs which could not be torn down without considerable trouble, and at best the centre would not be likely to come out true, so I knew the only sure place for it to turn was in the head, where it belonged. Then it was that all kinds of ideas came to me, but the only one that looked clear was this: first I put on a large mill, say about 4 or 5 inches diameter, and took the plate shown in sketch at Fig. 2, and with an angle protractor set the plate at an angle of 30 deg. bolted on the dividing head, and brought the platen up so that the center came against the side of the mill on the under side of the cutter arbor, as shown at Fig. 1; which in my case was a plain milling machine. Of course a universal milling machine does not need the plate mentioned, as it can be set over at the proper angle. After all this is done, all that is necessary is to turn the center slowly and the results will be surprising.



Chicago, Ill. C. H. WHIPPLE.

ADJUSTABLE GAGES.

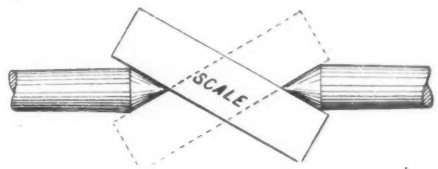
The article by John T. Usher on snap gages in the November number of MACHINERY reminds me of an experience with solid snap gages some time ago. I was in a shop which had a number of fine tools, gages, etc., as they intended to have everything "interchangeable." A good deal of reliance was placed on solid snap gages, and they were used considerably. After awhile they commenced to wear enough to be noticed, but as is generally the case with such things they continued in use, the workmen making allowances for wear in calipering. One time there came an order for some work to be done as soon as possible, and a workman had a number of bolts and studs to make which were to be driven in place. When the machines came to be assembled, most of these bolts and studs had to be reduced—some by filing and others by turning in a lathe.

The foreman was surprised at this and would have laid the blame on the workman who did the job, but when he was shown how the gages had worn he could not blame the workman, as he had told him the gages were just right. This was enough to convince the writer that solid snap gages could not absolutely be depended upon. This shop had standard plug and ring gages, but they were kept for reference and not commonly used; so that if a workman had made a running or driving fit, he had to proceed by the "cut and try" method. I think I know of a better way than that, which I will explain to such readers of MACHINERY who may not be aware of or use a different method. The method which I propose to explain requires a set of standard plug gages, to which the shop reamers should be kept to size with; these should be kept for the general use of the workmen. Now if a workman has plug a which he knows just fills the hole he is to fit his work to, it becomes an easy matter to make either a running or driving fit with spring or riveted calipers, provided he has had experience enough in using them, and knows the amount required in addition to his plug for making driving and shrink fits. As stated by Mr. James F. Hobart in the September number of MACHINERY, "almost any machinist can detect a difference of a quarter-thousandth in diameter with spring calipers." Now there are many good machinists who find it hard to believe this, but it can be easily verified by taking two plugs of just that difference in diameter (one-quarter thousandth) and calipering them, when the difference will be easily perceived. But it is not always necessary to caliper quite as close as this, except on work of very small diameter. In making a running fit the caliper could be set to plug and the work turned to the same diameter or a little under. In making a driving or shrink fit, the calipers should be set to plug with packing between one end of calipers and plug to the amount required. I will not pretend to give the exact amount, but in my experience I have found that to make a driving fit on work up to 2 inches in diameter, I would leave the work from .0015 inch to .002 inch larger than the plug; the amount to increase as the diameter increases above 2 inches. To make a shrink fit as in turning a crank-pin to shrink in crank by heating the latter, I should leave about .002 inch per inch in diameter up to about (5) five inches, the amount per inch to diminish as the diameter increases above 5 inches. Of course we should add a small amount of this to allow for filing work smooth. It is always easy enough to get packing about the required thickness; the average newspaper being about .0035 and tissue paper .0015 inch.

J. T. G.

TESTING CENTERS.

Coming across the article by Mr. Hobart in one of your earlier issues, it occurred to me that the old and simple device shown with this might be new to some of the boys, as such kinks are by



no means universally known. Run the back center up till a scale just fits between it and the line center as shown, then see if it it will go between them in the reverse position as shown by the dotted lines. It is very simple and gives fairly accurate results.

Marshaltown, Iowa. EDWIN H. POWERS.

* * *

DON'T let that "scrap pile" get too big—you never find time to look through half of it—better sell it for old metal.

* * *

IN describing the interesting "Apron Details of the Springfield-Muller Lathe" in our February issue, we inadvertantly omitted part of the firm name. This should have been the Springfield Machine Tool Co., Springfield, Ohio; and any inquiries regarding their new lathe should be addressed to them.

* * *

THERE is a great difference in the way gears are put up, a little trouble and a few extra dollars making the difference between unbearable noise and quiet running. A small lighting station used a water wheel of about 75 H. P., and bevel gears were used which were evidently not put up in the best shape, as after they started up at night the engineer had to take the visitor *outdoors whenever he wanted to talk to him*, as the noise was so great in the station it was impossible to be heard.

MANUFACTURING NOTES.

THE LODGE & DAVIS MACHINE TOOL CO., of Cincinnati, O., are developing a large and extensive export trade. Aside from their regular resident agents in England, France and Germany, they now have thoroughly experienced salesmen from the United States travelling in Russia, Turkey, South America and Mexico. They will ship to New York City within the next ten days two carloads to machine tools, to be forwarded to England, France, Germany and South America. They are also at work on a heavy slab-milling machine, specially arranged for making moulds for the Washington Carbon Co. for their new plant.

ARCHITECTS are making plans for the new plant of the Albro-Clem Elevator Co., to be located at 7th street and Glenwood Avenue, Philadelphia, Pa., and erected at once, on a large tract of ground recently purchased by the company. The Pennsylvania R. R. and the Philadelphia & Reading R. R. will have sidings into the works. This plant when completed will be one of the largest and best equipped in the country for the manufacture of passenger and freight elevators and elevator appliances of every description.

THE WESTINGHOUSE MACHINE CO.'s steam engines find a market in the remotest corners of the earth. A 150 H. P. compound of the latest type was recently shipped to Alaska. The trade of this company in foreign parts holds up well, orders having just been completed for three 150 H. P. compounds to Mexico, 200 H. P. compound to Spain, 300 H P. compound to France, 150 H. P. compound to Buenos Ayres, 800 H. P. compound to Havana, Cuba, besides a number of smaller engines to Russia and elsewhere.

ELM CITY, No. 10, N. A. S. E., of New Haven, is hard at work on educational matters, subjects of a practical nature being discussed under the instruction of Mr. W. H. Wakeman.

* * *

FRESH FROM THE PRESS.

THE mechanical considerations which are involved in producing a bicycle for rough road use which weighs less than 23 pounds, are of interest to all mechanics. The new catalog of the Pope Mfg. Co., of Hartford, gives some of these points, and the artistic way in which they are shown make them attractive as well.

ERNEST F. ROBBINS, Burrville, Conn., issues a standard size catalog for 1895, showing among other things his milling attachment for lathes and a novel "knotted" scriber.

PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. Francis B. Crocker and Schuyler S. Wheeler. 206 pages. D. Van Nostrand Co., New York. $1.00. The fact that this little book has reached its third edition shows that it is appreciated. Written by two thoroughly practical men it deals in a clear and concise manner with the essential features of dynamo and motor care and management, a subject of vital interest to many engineers, for the dynamo is becoming the rule rather than the exception in the engine room. The chapters on testing are especially valuable, while the information about locating and correcting trouble will gladden the heart of many a perplexed dynamo tender or engineer.

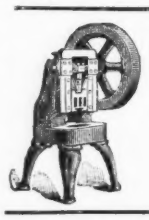
MESSRS. THEO. AUDEL & CO., New York, send us their latest catalog of books on engineering subjects, making a specialty of the books for engineers by Mr. N. Hawkins, whose works are favorably known among practical men. These are by no means all of their publications, and those who are interested will do well to send for a catalog.

PRAY'S STEAM TABLES AND ENGINE CONSTANTS. Thos. Pray, Jr., C. C. & M. E. 132 pages, 6½ by 10 inches. D. Van Nostrand Co., New York; E. & F. N. Spon, London. $2.00, This contains many tables of value to the engineer, being "the most needed computations" for everyday work. It is impossible to convey an idea of the amount of labor involved in computing the tables of this book, but it will be appreciated by those who have use for such tables, accuracy being their main feature. Among the many valuable tables those of engine constants for cylinders 6 to 117 inches in diam., of temperature of steam to 350 pounds pressure, and the hyperbolic logarithms to five places, will be highly appreciated.

THE ENGINEER AND CONTRACTOR, a new weekly published in San Francisco, Cal., has favored us with a complete file of its issues to date, six in all. It is devoted to engineering matters in their broader sense, and its price places it within the reach of all who have use for such paper, being $1.00 per year to the United States and Canada.

THE OHIO VALLEY INDUSTRIAL REVIEW is the name of a new monthly published in the interest of manufacturers in the Ohio Valley. Its first number contains articles by Mr. Chas. Davis, Mr. Thos. P. Egan, Mr. Robert Laidlaw, Hon. Bellamy Storer and others, with portraits of the first three named. Its price is $2.50 per year, 25 cents a copy.

STILL another new publication has ventured to come forth, and in Lord's "Power and Machinery Magazine and Builders' Handbook" we have a monthly which contains much of interest in its initial number. Mr. William Wright forms the subject for the first article, while Mr. Lippincott appears in connection with his specialty, the indicator. The price is $1.00 per year. Address Guild & Lord, 320 Atlantic Ave., Boston.



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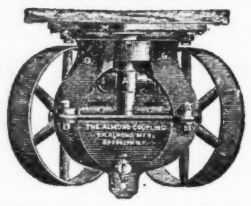

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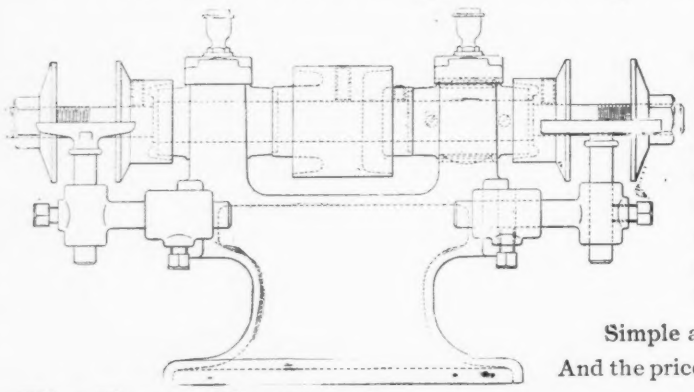

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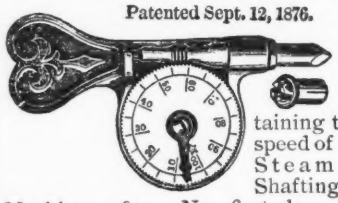

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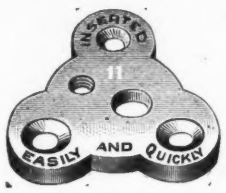

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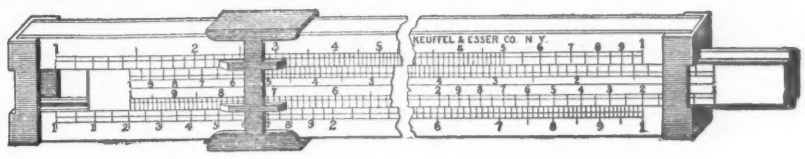

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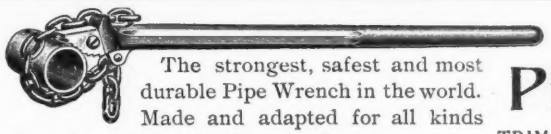
Catalogue on application.

The largest and best stock of DRAWING MATERIALS in existence.

"SHE IS FINE AS SILK,"

Says one of our recent customers, speaking of our : : : : : : : Forming Lathe.
YOU would say the same if *YOU* had one.
YOU cannot compete without one; the other fellow has his already running.
WHAT DO YOU SAY?

The Meriden Machine Tool Company,
100 Britannia Street, Meriden, Conn.



The strongest, safest and most durable Pipe Wrench in the world. Made and adapted for all kinds of work as well as hard or rough usage.

Trimo Giant
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TRIMONT MANUFACTURING CO.,
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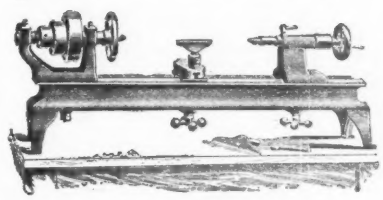
ARE YOU NOT IN WANT OF A **Bench Speed Lathe?**

THIS is an excellent high-class lathe, with a capacity of 20 inches between centres. The bed is 3 feet long, and the swing is 8 inches. Steel spindle in head, with half inch hole through it.

PRICE, - - - - - $25.00
PRICE OF COUNTERSHAFT, 8-IN. DROP, 7.00
Send for our No. 10 Catalogue. : : : : :



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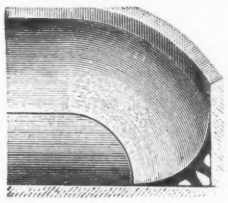

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Send for Reduced Price-List.
HOWARD WHITE,
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CUT SHOWS FULL SIZE. Order by Number.
WRITE FOR DISCOUNTS.
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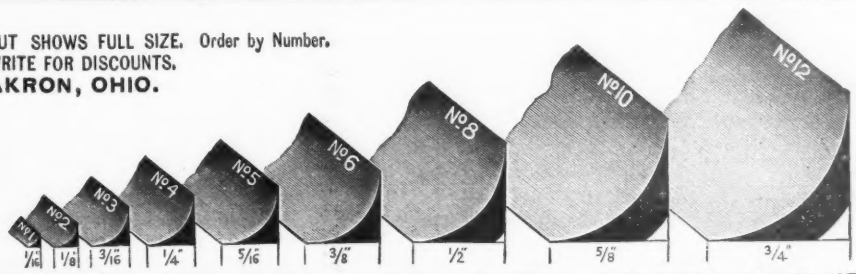

Foundrymen and Everybody, take Notice OF SMITH'S LABOR-SAVING LEATHER PATTERN FILLET. Have you seen it? If not, write for a free sample. We have no drummers. We want you to write us and get a sample to convince you. UNCLE SAM will deliver you by mail 100 feet of any size from 1/16 in. to 3/4 in. radius, for from 5 cents to 25 cents, according to size. UNCLE SAM will not charge Californians more than Ohioans. We charge you UNCLE SAM'S rates. Order by number. Address all communications to

SMITH'S PATTERN WORKS, 102 E. TALLMADGE ST., AKRON, OHIO.

Silver's Power Post Drill.

Has CUT GEARS, and is a thoroughly first-class tool in all respects. Diameter Column, 4½ in.; Diameter Spindle, 13-16 in. and bored No. 2 Morse Taper; Vertical Travel, 6 in.; Drills to centre 16 in. circle.

WEIGHT, 325 POUNDS.
PRICE, $60.

Wheel holding attachment for drilling tires, extra, $2.00.

Hand Drills,
Single and Double Geared.

Large and complete line ranging in price from $6 to $25 list. New price list just out.

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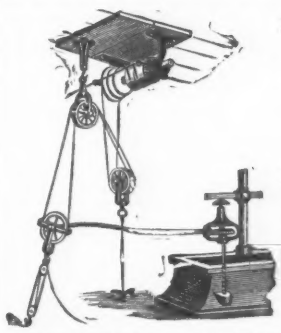

For Tapping and Reaming Stay Bolt Holes in Boilers.

PORTABLE DRILLING.

STOW MFG. CO.,
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SELIG SONNENTHAL & CO.,
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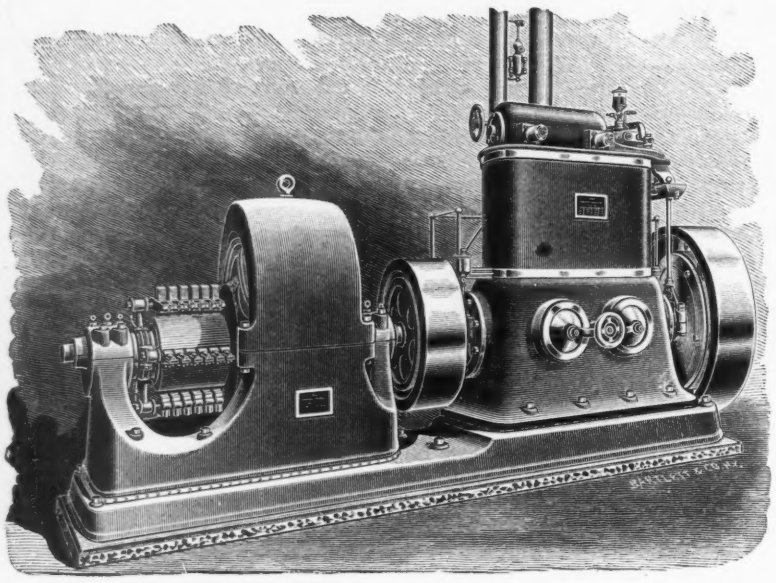

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LINE UP with every advancement in Steam Engineering, and to-day stand for the best modern ideas in

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Three Types.

- COMPOUND.—5 to 1,000 H. P. For Electric Lighting, Power Stations, etc., etc.
- STANDARD.—5 to 250 H. P. A High-class Automatic Engine.
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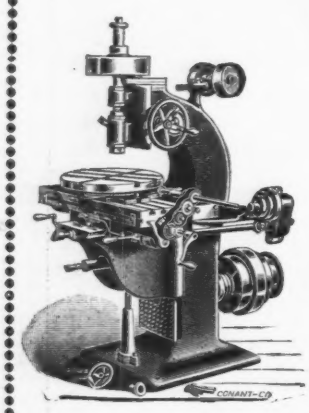
Becker Miller No. 4.



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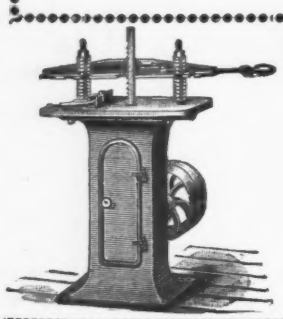
ENGLAND—CHAS. CHURCHILL & Co., Ltd., 21 Cross St., Finsbury, London, E. C.



UPRIGHT DRILLS,

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AND SPECIAL MACHINERY.

The W. P. Davis Machine Co.,

Write for Catalogue and Prices.

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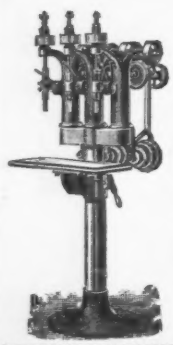

For all classes of light, rapid and accurate work and embodying many new and original improvements. Adapted for drilling all classes of holes from 0 to ½ inch, to the centre of 12 inches and to 4 inches in depth. Write for a complete catalogue.

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The Norton & Jones Machine Tool Works,

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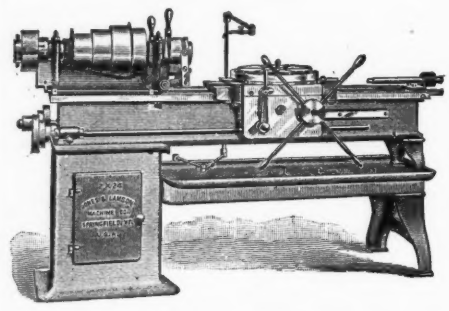

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SOLE BUILDERS OF THE

FLAT TURRET LATHE,

And other Turret Machinery.
Send for Catalogue.

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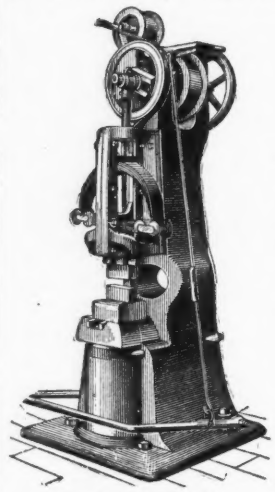

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1. Occupies less space:
2. Requires less power:
3. Is simpler in construction:
4. Works stock of greater extremes in size:
5. Strikes a truer and firmer blow than any other hammer made with same weight of ram.

Mention MACHINERY.

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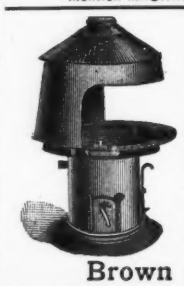

FORGES.

Compact and durable. No water required to keep them from burning out; can be lowered to clean the fire or allow of a large volume of heat for special requirements. . . . .

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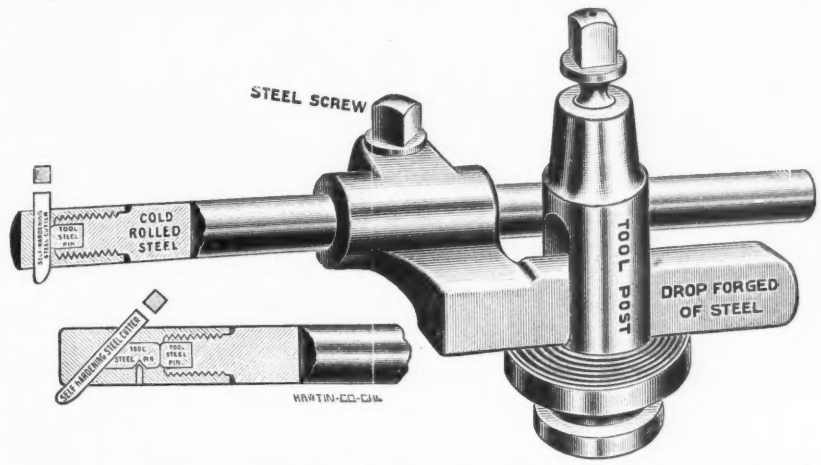
The ARMSTRONG BORING TOOL,

A Practical all around Boring and Threading Tool.

Especially adapted for the economical use of Self-Hardening Steel



The above cut shows tool in tool post. The end of bar, and cap for fastening cutter is shown in section. Each bar is furnished with two end caps; one holding the cutter at right angles with bar, and the other holding it at an angle of 45 degrees.

STYLE OF WRENCH FURNISHED WITH TOOL.

The Round side slips over cap on end of bar, the slot engaging cutter, by means of which the cap is screwed up, pressing cutter against hardened steel pin, which holds it perfectly firm. Square side fits the steel collar screw in split hub.

We have tested this tool thoroughly and feel safe in offering it to our customers and the trade in general as the BEST AND MOST UNIVERSAL BORING TOOL ever put on the market.

This tool is made entirely of steel, the wearing parts are hardened, and it is finished in a first-class manner. The bar can be extended from its holder to any desired length to suit depth of hole. The cutters can be ground for V, or square thread, double end, round nose, or any desired shape; they can easily be made by simply grinding end of piece of steel to the proper shape on a dry emery wheel, then nick all around on corner of stone and break off with sharp blow of hammer.

The saving in time, money, labor and annoyance, can hardly be over estimated.

It saves the men from going to the tool dresser, machine standing idle, etc. One of these tools will take the place of about a dozen forged tools.

At present they are made in two sizes only. We will soon get out two other sizes, and it is our intention to furnish all sizes for which there is a demand.

ARMSTRONG BROS. TOOL CO.

We received the No. 9 Boring Tool and like it very much. Send us 4 more. Any practical man will like your tool holders, but it is hard to make men who are not practical see the advantage of any improvement.

Yours respectfully,
FRED W. SWEET.
General Manager Williamsport Machine Co., Williamsport, Pa.

STRICTLY NET PRICE LIST.

No.	Size of Shank.	Size of Bar.	Size of Cutter.	Price c'mpiete.	Extra cutters ground for bor'g.
9..	½x1 in.	¾ in r'nd.	¼ in. sq.	$3.60	15c. ea.
10..	⅝x1½ in.	1⅛ in. r'nd.	⅛ sq.	4.75	20c. ea.

Each set is put up in a lock cornered wooden box. It consists of a holder, and bar with straight and 45 deg. end caps, two cutters (ground for boring), wrench, and a piece of self hardening steel about enough for 10 extra cutters.

Extra warranted self-hardening steel in 3 ft. lengths. Enough to make 2 dozen extra cutters.

¼ in. square 60 cents per length. ⅛ in square 85 cents per length.

The publishers of MACHINERY will refund the cost of any tool returned within 30 days that fails to give satisfaction.

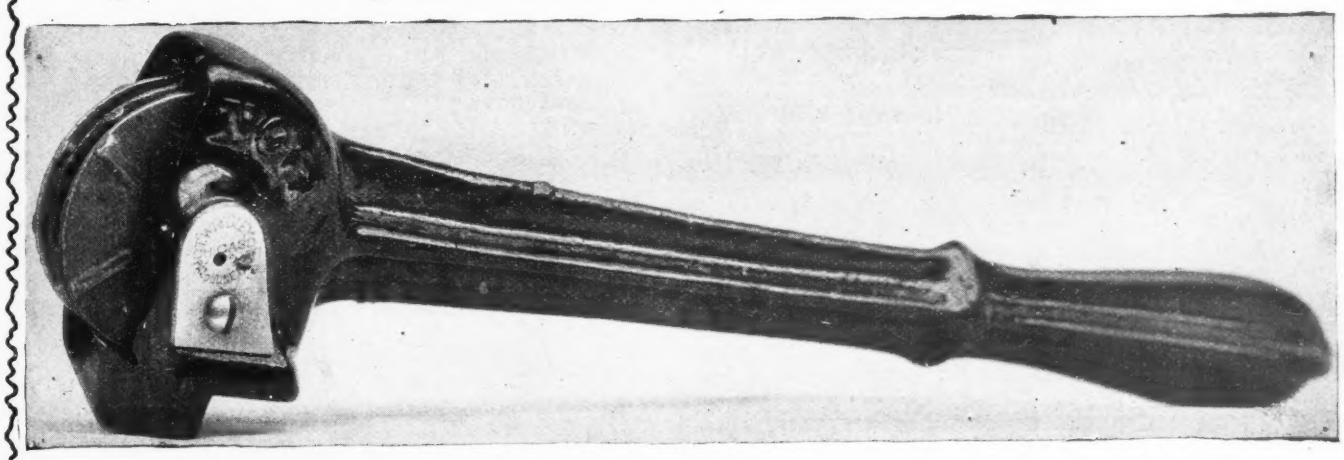
Manufactured only by

ARMSTRONG BROS. TOOL COMPANY 82 EDGEWOOD AVE., CHICACO, ILL.

SEE ADVERTISEMENT OF TOOL HOLDER IN NEXT NUMBER.

My Emery Wheel Dresser

is better than the best you ever used.



No. 1 DRESSER is 12 inches long, has 3 cutters, and is a tool for general work. Price, $2.00 each; Cutters, 15 cents per set.

No. 3 DRESSER is 24 inches long, and has six cutters. Used for facing very large wheels. Price, $4.00 each; Cutters, 30 cents per set.

This is the only Dresser in the market that has hardened steel washers at side bearings, as shown in sectional view of cut--the dresser being milled and slotted to receive same--which prevents the cutters from wearing out the sides. It has hardened steel bushings at pin bearings and all parts are interchangeable. When new parts are required, they will be sent by mail.

I will send a sample order to any responsible firm, express prepaid, on 30 days' trial, to be returned at my expense if not entirely satisfactory.

Notice that each Dresser has an extra set of cutters, and that my cutters are only 15 cents a set.

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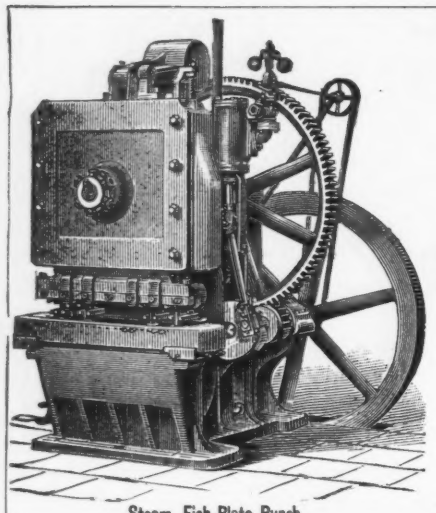

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Power Punches and Shears,

Belt, Steam and Electrically Driven.

FOR ALL KINDS OF

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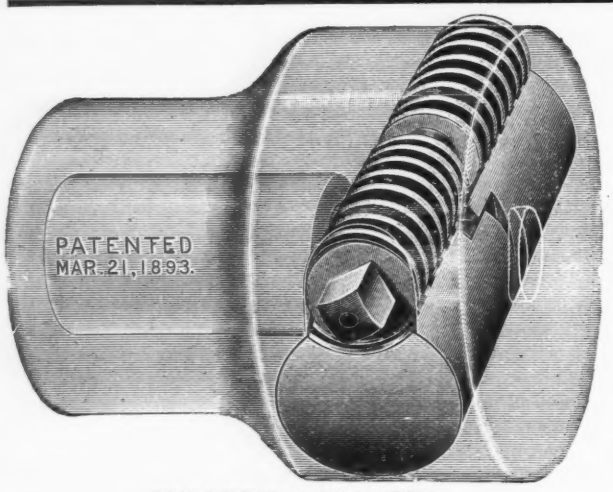

Half-inch Drill Chuck Style B. Full Size.

WE MAKE THE

DRILL CHUCK STYLE B,

IN 4 SIZES, AS FOLLOWS, VIZ.

Approximate Diam.	Will Hold Drill—	List Price.
1⅜ inch.	0 to ¼ in.	$7.00
2⅜ "	0 " ½ "	8.00
2⅛ "	0 " ¾ "	9.00
3½ "	0 " 1 "	10.00

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THE BURDICK PUNCH AND SHEAR

has been on the market for years, and to-day stands without a rival as a hand-power machine. :: :: ::
SIMPLE, POWERFUL AND EASILY OPERATED.
Reasonable in price and GUARANTEED in all respects.
A perfect machine for blacksmiths, wagon-makers, etc.
Full information cheerfully given.

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Boiler Maker's Steel Screw

Punches.

Let me make you a price when you want any.

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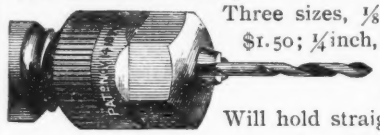
The Best and Cheapest Chuck Made.



Three sizes, ⅛ inch, $1.50; ¼ inch, $2.50; ⅜ in., $4.50.

Will hold straight or taper shank drills accurately. Manufactured by Trump Bros. Machine Co., Wilmington, Del.

Combination Reversible Jaw Chuck No. 21.

Improved Independent Chuck, No. 18.

Improved Independent Lathe Chucks.

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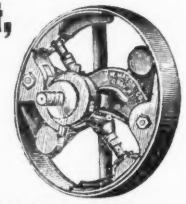

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Two Medals awarded at Chicago Exhibition.

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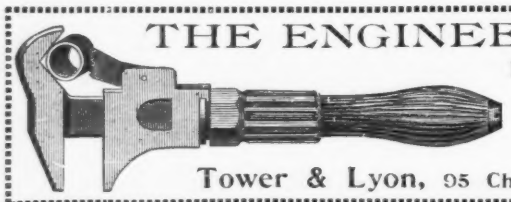

Perfect in Construction.
Steel Drop Forged.
All Parts Interchangeable.

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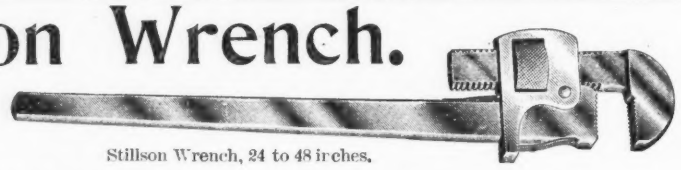
The Stillson Wrench.

Stillson Wrench, 6 to 18 inches.



Stillson Wrench, 24 to 48 inches.

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Sole Manufacturers of

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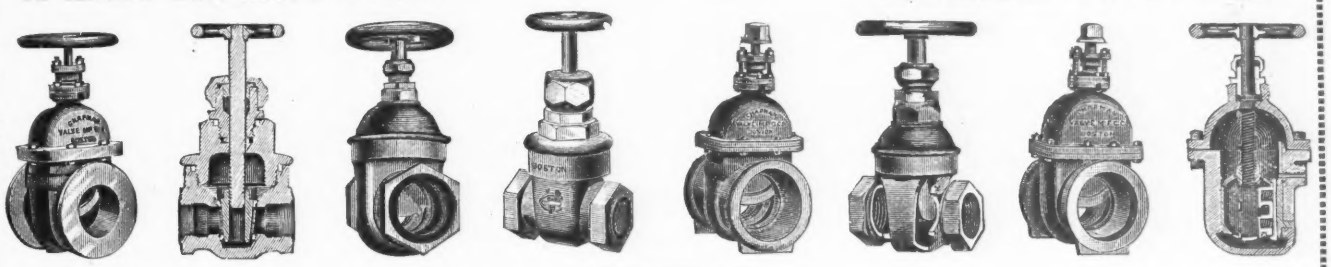

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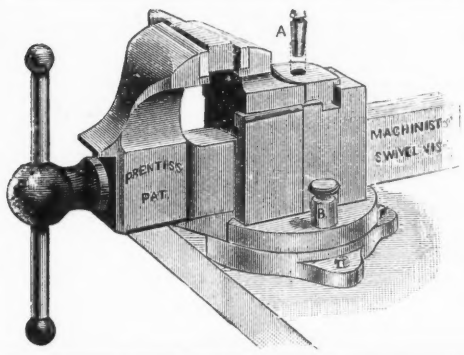
GATE FIRE HYDRANTS, With and without Independent Outlets.

WE MAKE A SPECIALTY OF VALVES WITH BRASS SEATS FOR HIGH PRESSURE STEAM.



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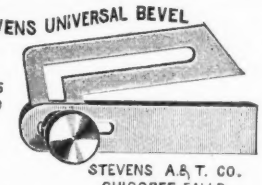
PRICE
1¼ IN.....$1.25
3 IN.....$1.50



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CHICOPEE FALLS.
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STEVENS' FINE MACHINISTS' TOOLS for many years have been the standard. Send for catalogue of Calipers, Dividers, Gauges, Countersinks, etc.

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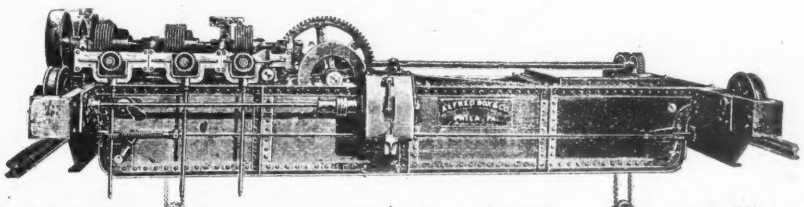
ELECTRIC TRAVELING CRANE.



The above cut represents our regular Crane, modified to suit buildings where it has been necessary to keep the runway within three feet of the ceiling; the operator's cage being omitted. These machines are driven with single motor, and have all the usefulness of the more complicated and expensive three motor types: and are built from five to forty tons capacity and any length of bridge required.

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Fonda's Improved Lathe Tool.

A new and useful tool for Pattern Makers and others to make Pins or round rods of wood for Dowels, etc. Can be used in connection with a power-turning lathe, held in the hand, or fastened in the tool post of a sliding-rest or carriage. - - - - - - PRICE, $3.00.

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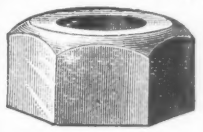
34 AND 36 FEDERAL STREET, BOSTON, MASS.

Port Chester Bolt & Nut Co.

Port Chester, New York.

MANUFACTURERS OF



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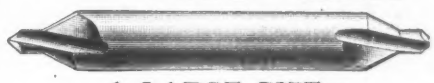
ACCURATELY FINISHED CASE HARDENED NUTS A SPECIALTY.

THEY SAVE TIME;

"TRY 'EM."



A LARGE SIZE.

Combined drill and countersink for centering lathe work.

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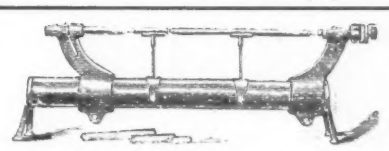

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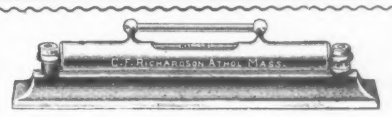

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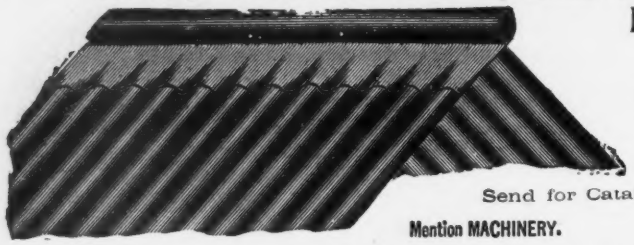

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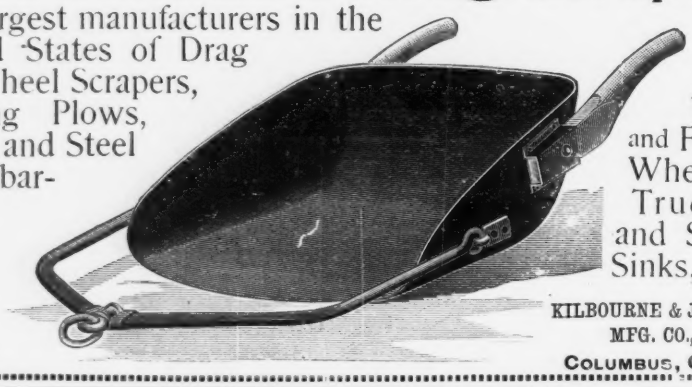

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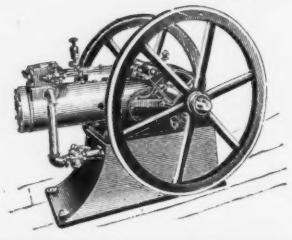

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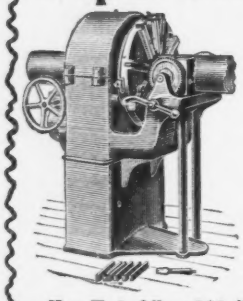

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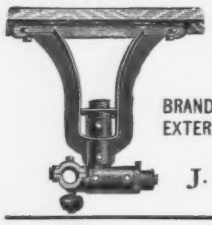

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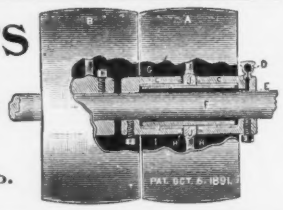

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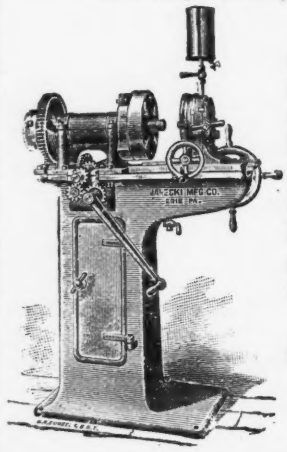

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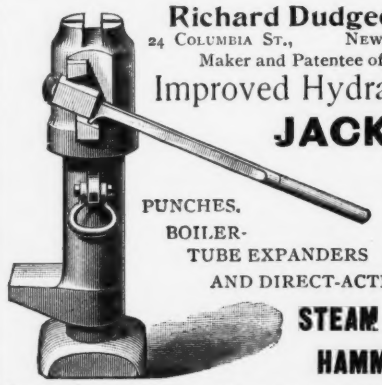

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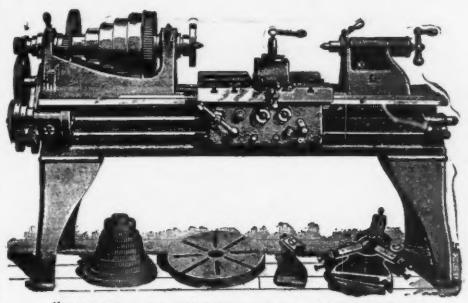

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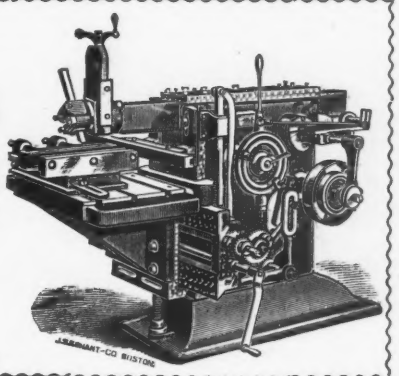

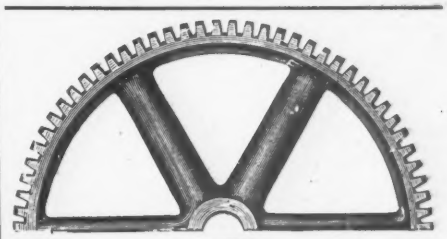

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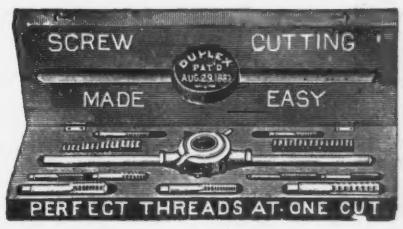

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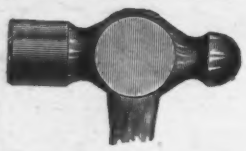

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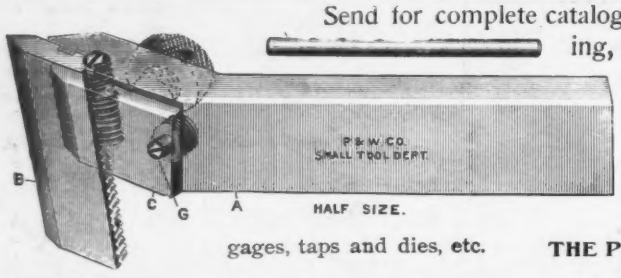

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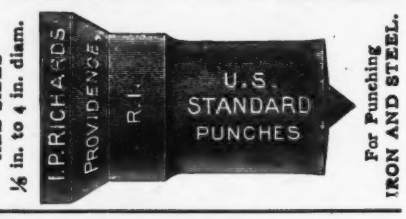

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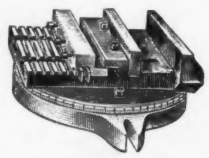

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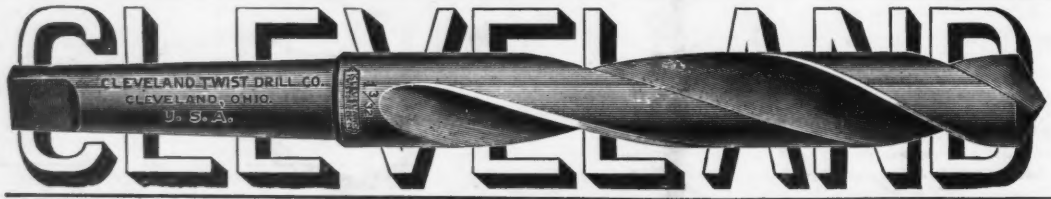

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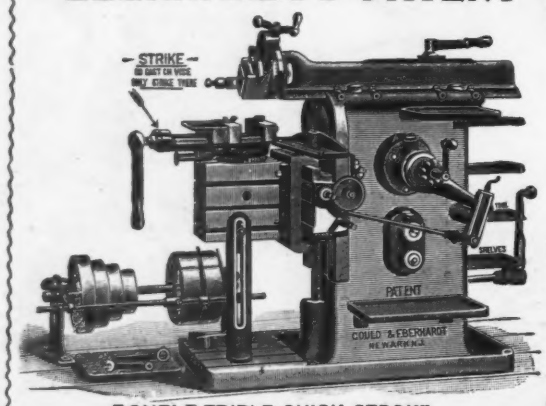

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